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NATURAL HISTORY

THE MUSEUM IN FIELD AND STUDY

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

EXPLORATION·RESEARCH·EDUCATION

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM

DEVOTED TO NATURAL HISTORY, EXPLORATION, AND THE DEVELOPMENT OF PUBLIC EDUCATION THROUGH THE MUSEUM

THE MUSEUM IN FIELD AND STUDY

A. KATHERINE BERGER, EDITOR

JANUARY-FEBRUARY, 1927

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Photograph by E. R. Sanborn, of the New York Zoological Society

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PALM TREES AND PINNACLES

These pinnacles of igneous rock, which form the most characteristic physiographic features of Komodo, give silent testimony of the live volcanoes that once were booming here. The low country in the foreground, covered with long grass and gubbong palms, is teeming with deer and wild boar. Yellow-crested cockatoos and a variety of game birds are also plentiful. Here it was that the first giant lizards were seen and captured. This beautiful landscape will be used as a background for the Dragon-Lizard Group in the American Museum

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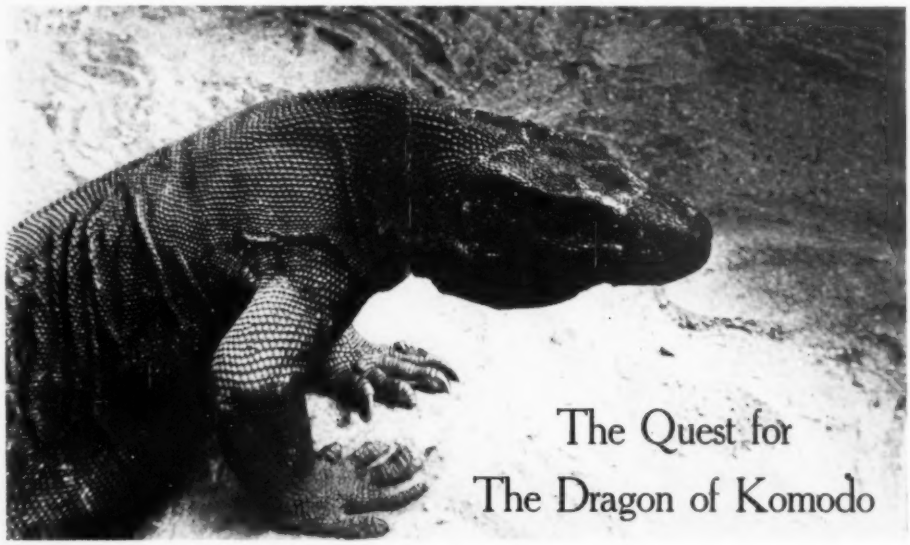


The Quest for The Dragon of Komodo

The giant lizard, *Varanus komodoensis*.—The skin of these beasts forms a veritable dermal armor or coat of mail, for each scale is underlaid by a plate of bone. (Photograph by E. R. Sanborn)

BY DOUGLAS BURDEN
Trustee of the American Museum

FOR a long time there have been various fantastic reports in circulation with regard to the size and habits of *Varanus komodoensis*, a big lizard from Komodo, one of the Lesser Sunda Islands in Malaysia. The first description of the species was given in 1912 by P. A. Ouwens of the Botanical Gardens at Buitenzorg, Java. Since that time only a few skins and no skeletons have made their way to European museums. Except for the original description, nothing whatsoever has appeared which added to our knowledge of these semimythical dragon lizards.

Our desire to study these beasts, coupled with the fact that the American Museum of Natural History had no collection from the Lesser Sunda Islands, and that there were many interesting problems in geology and zoögeography to be worked out in this region, finally resulted in our determining to go to the East Indies. Therefore, with the big lizard as the chief incentive, a small expedition was organized, the personnel of which included Dr. E. R. Dunn, one of the foremost herpetologists of the United States, F. J. Defosse, a great hunter from Indo-China, whose chief task was to capture the lizards alive, and a Chinese camera-man from Singapore, Lee Fai, by name. Mrs. Burden prepared herself to take charge of the still photography. Through the kindness of the Dutch Government, we obtained the use of an official yacht, the S. S. "Dog," for a period of two months.

The Rajah of Sumbawa, a neighboring island, acting on orders from the Colonial Government, assigned to us fifteen Malay hunters. They were a

wild outfit, consisting of independent tribesmen from the innermost jungles of the isles,—and rough looking cutthroats they were, their mouths all stained from chewing betel nuts, their lips distorted, and their teeth blackened or gone entirely.

The S. S. "Dog" on which we traveled more than 1500 miles. This official yacht was lent to our expedition by the Dutch Colonial Government

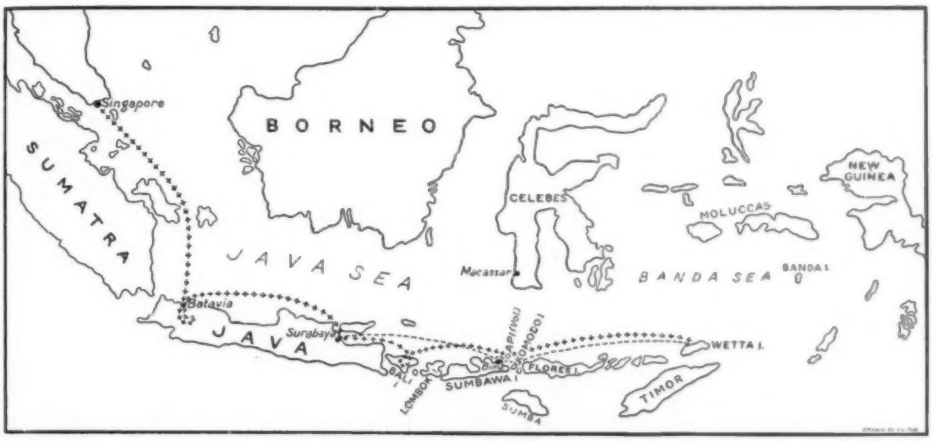
It was in Bima that we unexpectedly had our first sight of *Varanus*. Certain Chinese poachers had been brought in with two large specimens which they had just taken. The lizards caused great excitement among the natives, who had known the beasts only by villainous reputation. The larger of the lizards had increased this ill fame by attacking a horse that wandered too near, and inflicting such damage that the injured animal had to be shot.

On June 9, after a journey of 15,000 miles, we at last sighted the island of Komodo. At the first sign, I hurried up to the bridge and examined the dim outline of mountains through the glasses. In some respects it differed from what my eager imagination had pictured. Instead of lofty peaks, there were great areas of high land. A few wisps of white cloud hung over the mountains, and with the powerful lenses I could discern patches of jungle.

It was an important moment, yet, as I turned to the captain, I noted that he preserved his usual professional calm. I expected him to show at least some realization that we were entering waters which were said to be very difficult of passage, for we were now in Linta Straits, of which Wallace writes that the violent tide rips cause the sea to "boil and foam and dance like the rapids below a cataract, so that vessels are sometimes swamped in the finest weather and under the brightest skies." Already we were entering the zone of rough water, and I could see it boiling and churning between the upraised coral reefs strewn about. But the captain, instead of barking out new and excited orders, stood silent, with an air of entire confidence in the boat and in the orders already given.

On returning to the deck, I found my companions attempting to continue the occupations of the moment, but there was an unmistakable undercurrent of excitement. That wily old hunter, Defosse, was itching to stretch his legs on shore. I could tell by the way he was polishing his rifle and fingering the trigger. Doctor Dunn was restlessly thumbing the pages of his book, while Mrs. Burden, swinging in a hammock, forced herself to continue with her novel as if real adventure could wait. Lee Fai, with true Chinese conceptions of geography, hadn't the slightest notion where we were, but rather expected to reach Manila soon.

After all, however, the period between sighting the island and the actual landing was a long one. There was



The route of the expedition.—The dotted line represents the outward journey from Surabaya, Java, to the little town of Bima in Sumbawa, thence to Komodo (the small island lying between Flores and Sumbawa), and to Wetta. The crosses show the return journey to Singapore by way of Api volcano, Lombok, and the far-famed island of Bali

really no way for us to show the excitement we felt. I have no doubt that those intrepid explorers who finally reached the North and South poles could say little more than, "Well, here we are. What now?"

We were soon threading our way among the outlying coral rocks. The beauty of the scene recalled to my mind a bit of poetry by Oliver Wendell Holmes that seemed to have been meant to describe this very spot:

The venturous bark that flings
On the sweet summer wind its purpled wings
In gulfs enchanted where the siren sings,
And coral reefs lie bare,
Where the cold sea-maids rise to sun their
streaming hair.

As we came closer to the island, I could see beyond the scant growths of tall "gubbong" palms naked pinnacles of rock whose black heads reared up to the sky. Their sculpture was bold and their outline fantastic. These wonderful physiographic forms showed us at once that Komodo is not limestone, as has been reported, but volcanic, for these striking features of the landscape are volcanic necks, or plugs, formed by the cooling of molten magma within the vents of volcanos. From the condition of these plugs it was evident that the volcanic action had ceased long since, for erosion had washed away the cone, leaving the more durable igneous core standing aloft as a record of the ancient turmoil.

It struck me that the process of erosion was far more advanced on Komodo than on the other Sunda islands. In the others visited by the expedition it was still in a youthful stage. Since the climatic conditions and the character of the rock are uniform throughout the chain, this difference indicates either that volcanic activity became dormant very early, or that Komodo is actually older than the others—an interesting consideration in determining the reasons for the restricted range of *Varanus komodoensis*.

I soon put aside theorizing, however, for we had slipped suddenly from the churning waters into the calm of a little harbor, and had come to anchor in the lee of a tiny island. After the cramped quarters on the boat, we were eager to land, and the weird beauty of the spot was already beginning to work its magic. The shore

The home of the dragon lizard.—A glimpse of the rugged mountains of Komodo. Under a broiling, tropical sun, it was exhausting work to climb around these precipices

was a curving ribbon of shining sand; beyond, the tall gubbongs stretched aloft like sentinals to the sky.

As we neared the beach, we jumped out of the small boat and waded in to shore. Mrs. Burden and I ran along the edge of the surf casting our eyes this way and that to enjoy the glorious scenes that charmed us at every turn. Everywhere we caught signs of abundant game,—particularly deer and wild boar. They seemed to be countless.

Just as we went on board again, the sun was setting, and the rocky islets and purple sea were catching tints of gold from the sun and showers of color from the changing sky overhead.

Late that night I heard tom toms beating across the water, a thrilling and barbarous rhythm, in a ceaseless monotone. A native prau was anchored in the bay, and the drum beats were a summons to the god of the winds to send good blowing weather on the morrow. The potency of this summons is never doubted by the children of the Eastern Seas.

Early on the morning of June 11 we started to explore the island. Our object was to find a camping site where tracks of the big lizard were plentiful. Defosse and Doctor Dunn set out to the north, while I went directly west over the mountains. Lee Fai, as tired as if he had been laboring for months, remained on the ship in repose.

After many hours of hard climbing, we reached the divide. Here we saw an abundance of game, and I had no difficulty in bringing down a fine buck which we needed as meat.

A day later I discovered a beautiful camping site at an altitude of nearly 2000 feet, where there was an ample supply of good water. It was a glorious spot, so I hurried back toward the bay to announce my find. The return was not without adventure, however, for I had my first encounter with a Komodo wild buffalo or "carrabao" which we had not known existed here. And I found the beast a more pugnacious customer, if anything, than those of Indo-China. I was intent upon locating some blue pigeons whose booming I had heard, and pushed into some thick bamboo jungle at the edge of a water hole. The place was far from deserted. First a flock of ducks flew up, and then there was a terrific crashing off to my right. A native with me cried in terror "Carrabao!" and at the same moment I saw a wild buffalo not twenty-five yards away, headed toward me. His nose was in the air, his horns seemed to be laid back against his flanks, his nostrils were dilated, and from the speed with which he was coming, I saw that he intended to charge me. I had no steel bullets, and as lead bullets were of no use in this case, I took to my heels. I was much relieved when he finally stopped on the edge of a thick jungle whither I had run knowing that these animals will only attack on hard, open ground.

I arrived at the beach dead tired, and found that Doctor Dunn and Defosse had enjoyed a highly satisfactory day. They had found plenty of lizard tracks, and such a variety of bird life that even Defosse felt that Komodo hardly needed the addition of tigers and elephants to make it a sportsman's paradise. The game birds included blue pheasant, jungle fowl, five or six different species of pigeon of untold beauty, turtle doves, quail, ducks, and a yellow-legged running hen which bears a close resemblance to the tinamoo of Central America. Moreover, the noisy yellow-crested cockatoos were always in evidence, flying over the jungle and chattering raucously.

By the middle of June we were comfortably encamped in a spot commanding a wide view. The whole front of our little hut was open to the sea breeze. The roof of woven palm leaves was mellow and bearded with age, and rattled dryly in the wind. From the edge of it dangled all manner of tangled growths amid which a swarm of malignant things found concealment,—spiders, scorpions, centipedes, lizards, snakes,—we never knew what to

Tracks of a large *Varanus* in the mud. In the millions of years to come such tracks as these may well be the fossil imprints of an extinct species

expect next. Very early we found a green pit viper there.

Inside, we soon had many evidences of a real home. Clustered around the lamp on the table was a miscellaneous collection,—ammunition, notebooks, flash lights, boxes of every variety. We slept on a raised bamboo platform.

As soon as we put out baits for *Varanus*, they began to flock around in considerable numbers. Doctor Dunn took his stand where he could not be seen by the creatures and watched them all day. His notebooks soon began to bulge with meticulous notes recording every move of each beast and the exact time of each move. Lee Fai obediently went out under orders to take pictures, but always returned soon, grumbling to himself that "walking much trouble." Defosse was not wholly content with scientific observation; he wanted action. He pulled his mustache; he cleaned his rifle; and his conversation always reverted to Indo-China, and the glorious hunting in the country north of Saigon.

For the rest of us, we found sufficient

excitement for a while in observing the feeding habits of the great dragon lizards. For hours together we watched them from the "bomas" or blinds, as they devoured the bait. Voracious as they were, it was interesting to note what careful watch they kept, especially the smaller ones, who seemed terrified when an adult made his appearance. Whenever we saw a smaller one turn and dash away with lightning-like rapidity, we knew that a big lizard was approaching. For several minutes no lizard would be seen, then suddenly, from behind a tree, a big black head with two beady eyes would appear. For a while it would remain absolutely motionless; only the hawklike eyes would move, peering grimly from under bony "eyebrows," while they surveyed every inch of the surrounding territory. Then, assured of safety, the beast would lower his head, and with his long, yellow, bifurcated tongue constantly darting forth, he would move ponderously toward the bait. As he walked, the impression he gave was of tremendous weight and strength.

Mr Burden studying Malay.—It was so cool in camp on the summit of Komodo that one could sit in the bright noon sunlight without discomfort

The miraculous Chu, our Chinese boy from Peking, cooking at seashore camp. The palm-leaf boxlike structure —the handiwork of Chu—is an improvised oven

Although the small ones are rather slim and agile, the adults are thickset, muscular creatures with very heavy bodies. After they have attained a length of seven feet their weight increases out of all proportion to their length, and doubles, I think, between seven and eight feet.

Dr. E. R. Dunn of Smith College, a leading authority on reptile life, and herpetologist of the expedition, holding a green pit viper. Komodo can boast of all three classes of poisonous snakes: cobras, vipers, and pit vipers

In the process of gorging, the long sharp claws are used indiscriminately for scraping and tearing, while the thin, recurved teeth with sharp serrated edges are employed to rip off chunks of the meat. The beast maneuvers this by seesawing back and forth on braced legs, giving a wrench at the bait with every backward move. Seen thus, with jaws buried in the meat, and neck curved forward and down, he bears a remarkable resemblance to *Tyrannosaurus* as restored in modern paintings.

Whatever he can wrench off, regardless of size, is swallowed at a gulp. One big fellow took in the whole hind quarters of a deer,—hoofs, legs, hams, vertebræ, and all. If he is surprised when feeding, the result is likely to be disastrous, for the weird beast becomes excited and immediately disgorges.

With such pictures in mind, I tingled with excitement at my first sight of one of the huge creatures in the open.

I was at the foot of the pinnacle country, on a gently sloping talus cone covered with short grass and a few palm trees. This was the very section of the country in which the Duke of Mecklenburg is said to have shot three of the beasts in chance encounter. Here I saw a lizard working his way slowly down the mountain. I scrambled up to a point of vantage, taking care not to expose myself to view, as the eye sight of *Varanus* is much keener than that of a deer. It was a marvelous picture,—a primeval monster in a primeval setting. Had he only stood up on his hind legs, as I now know he can do, the dinosaurian picture would have been complete. Against a background of sunburnt grass he looked quite black with age. As he approached, three pigs dashed away into the distance. Once he stopped for a long time with his nose buried deep in the grass, as if scenting out some shrew or rat or small lizard to add as another choice morsel to his already distended stomach. In my glasses he filled the whole field of vision, and as there was nothing by which to compare his size, I could quite easily imagine him to be twenty or thirty feet long. I was wrong, however, for they do not exceed ten feet in length. I was filled with a longing to bag one of these creatures alive, and after he disap-

peared from sight, I hurried back to arrange for more active hunting.

It was Mrs. Burden, however, who had the first exciting encounter with one of the lizards. Together with Defosse, she went out early one morning to see if any marauding *Varanus* had been at the bait during the night. Upon reaching the blind, they were dismayed to see that the bait had been torn in half, and the entire hind quarters devoured. It was hardly conceivable that one V. K. was responsible for so much mischief. As there was now no animal in sight, they hunted for tracks around the bait. Defosse followed them around on one side of a hill, while Mrs. Burden searched the other side. Suddenly a movement at the edge of the jungle to her right fixed her attention, and then one of the antediluvian monsters peered out from the cover of the jungle. For a moment he stood so, then with ponderous movements he crawled out into the light of day. At the same instant, Mrs. Burden sank motionless into the tall grass.

As he approached step by step, the great bulk of his body was held clear off the ground, and the black beady eyes flashed in their deep sockets; from time to time, as he stopped and raised himself on his powerful forelegs to look around, she could observe the blistered scars on his bony armor.

"As he drew nearer," she afterward related, "I suddenly realized my predicament. My gun was propped against the blind where I had left it a few moments earlier. Defosse was out of sight, and the great reptile was continuing straight toward me. Should I jump up and run, thus losing the largest lizard we had seen? Should I not rather lie without moving in the chance that Defosse would come back in time to shoot him, or that he would change his course and pass by me unheeded?

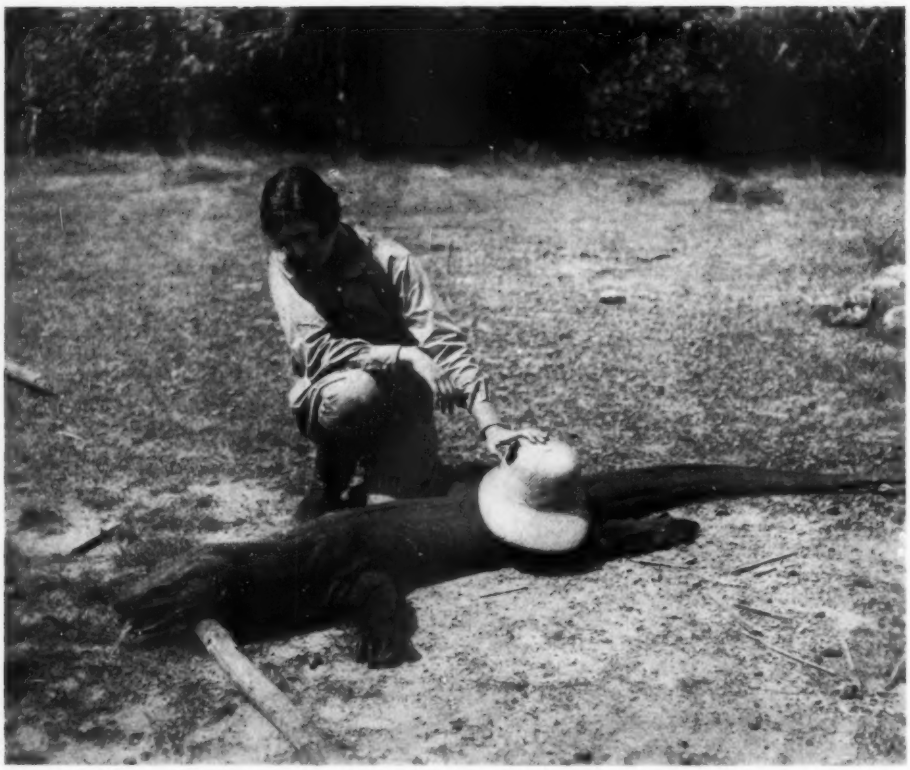
"Nearer he came and nearer, his grim head swinging heavily from side to side. I remembered all the fantastic stories I had heard of these creatures attacking both men and horses, and was in no wise reassured.

"The creature was now less than five yards away, and its subtle reptilian smell was in my nostrils. Too late to leap from hiding,—if I did, he would surely spring upon me, rending me and devouring my remains as he had devoured the dead deer. Better to take my chances where I lay, so I closed my eyes and waited.

"Then I opened them in time to see Defosse's head appearing over the hill. The next instant there was a flash, and a bullet buried itself in the great monster's neck. Like lightning he whirled and crashed toward the jungle, but the rifle once more did its work, and he lay still."

Later, upon measuring him, we discovered that he was not quite ten feet long, but he must have weighed around 250 pounds, and in his stomach we found the whole hind quarters of the deer!

We were by now even more anxious to capture alive some of these very large lizards for closer study. Several times the Malays had seen a particularly ugly brute on the edge of the "prehistoric" wood, which they excitedly described as the biggest "boeaja darat" (land crocodile) yet seen. He was a very wary fellow, and we decided that the best way to get him alive would be to build a trap at the edge of the forest, bait it with deer or pig, and then hide close by in a boma, ready to run out and lash him to a pole as soon as he was caught in the noose. Accordingly, Defosse killed an old razorback for bait and the coolies



One of the lizards shot by Mrs. Burden

set to work on the trap. Heavy stakes were pounded into the ground all around the bait, except for a large opening left at one end. The stakes were then lashed together with rattan and the whole contraption carefully camouflaged with branches and leaves. A live tree was selected as the spring pole. The branches were cut, the rope tied to the top, and then, with the combined strength of fifteen coolies, the tree was bent over and the noose set at the opening in front of the trap. To avoid having the trap sprung by some small and unimportant specimen, however, we arranged that the tree should be released only by a string running along the ground to the boma.

A test proved that this would work perfectly; already we visualized the surprise of the old dragon when the noose should snare him and the spring pole immediately snatch him aloft dangling at the end of his tether. The trap was Defosse's handiwork, and a credit to his ingenuity.

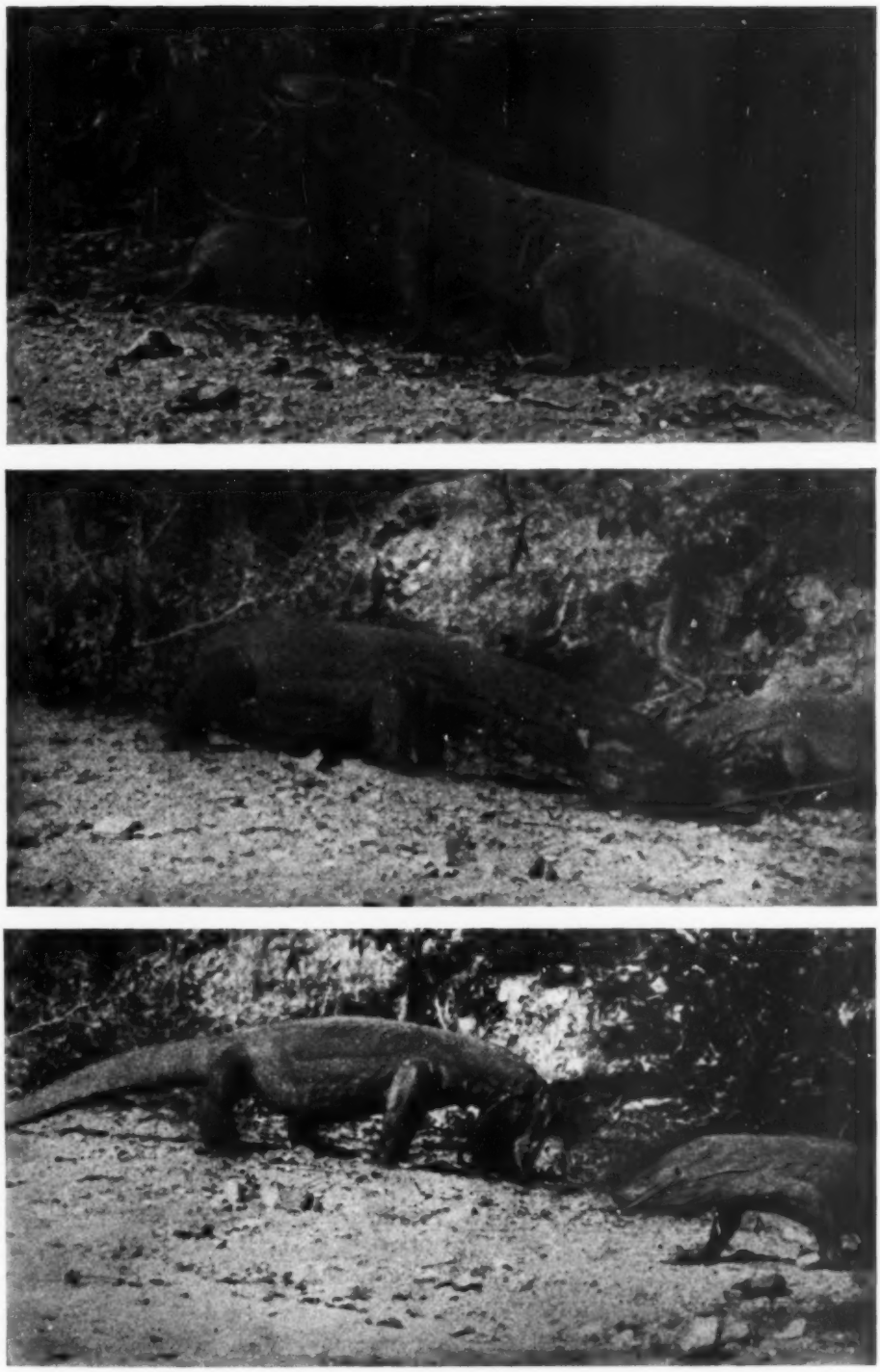
We were on hand early next morning, for the bait had already begun to smell. The sun was well up before anything happened to arouse our hopes. Presently a small V. K. appeared and maneuvered around and around the trap, not daring to enter. He was followed soon by a much larger beast about the size of those which we later brought back to the New York Zoo. This one immediately entered the trap and tried to drag the whole boar out, but the razorback had been lashed in place, and could not be budged. Presently I saw him look up and then

Building the trap.—One end of this boxlike trap is left open. At this opening the noose is set. The natives are seen camouflaging the trap with leaves. (From the motion picture)

Setting the trap.—The trap is now completely camouflaged so that it resembles a bush. The natives are bending the spring pole, while Defosse, at the entrance to the trap, is setting the noose. (From the motion picture)

HUNGRY

Varanus komodoensis, as he is frequently seen prowling around foraging among the gnarled mountains of Komodo. In the lowest picture he is seen coming full speed toward the bait. (From the motion picture)



FEASTING

When a dragon lizard attacks his food, he tries to swallow it whole. Failing in this, he rips and shakes it to pieces, greedily gulping great hunks much larger than his own head. (From the motion picture)

turn and flee as if the very devil were after him.

Only a very large V. K. could create such panic in one of adult size, so we waited with ill-repressed excitement. There was no reason to lower our voices, as the beast is practically stone deaf, yet a hush fell upon us which became a positive strain as time lengthened into half an hour, and no big beast arrived.

Suddenly a coolie peeping through the leaves at the back of the boma made a strange sound. Others looked, and stirred with excitement. When I looked, I could well understand their feelings, for what I saw was a V. K. so large and so villainous of aspect that I trembled with instinctive repulsion.

He started forward, headed straight for the boma. I could see the brute, now, very well. He looked black as ink. His bony armor was scarred and blistered. Half his tail had been lost in battle. His eyes, deep set in their sockets, looked out from underneath overhanging brows. Now his footsteps were plainly audible. He passed so close to our boma that I could have reached out and touched him.

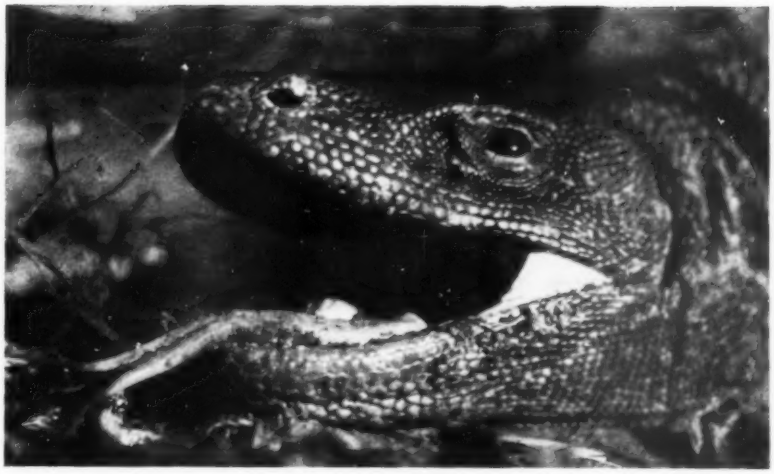
I was so excited that I wondered at the great calm shown by the hunter Defosse. He was able to give his principal attention to keeping the nervous coolies quiet, and did not seem to share the agony of waiting I felt for the next half hour, while the great reptile was making up his mind whether to enter the trap. He was wary and suspicious. He would put his nose almost in the noose, and then withdraw it. He inspected everything closely, his snaky tongue in constant motion. Then he would walk away abruptly, and sit for five minutes at a time looking into the surrounding jungle. It seemed as though we should never take him.

Then, of a sudden, it happened. He walked straight up to the opening, stepped through the noose, and seized the bait. I pulled the release, and the great dragon was catapulted into the air. Down he came as quickly, his great weight dragging the tree back again. Then it was a contest of strength between him and the tree, which began to crack noisily with the strain as he clawed at the ground, tugging at the rope which was tightened about his middle.

The coolies rushed out to surround him, but he held them off, not only by his fierce lunges, but also by vomiting and foaming at the mouth.

It was now up to Defosse, who had been practising with a lasso for months past. His first throw missed as well it might, for the great beast was leaping in every direction. But Defosse, keeping carefully and coolly out of reach, recoiled his rope as methodically as though he were practising on a tent peg in camp. Awaiting a favorable moment, when the lizard was trying to drag himself away in the opposite direction, Defosse stepped up close behind him, and dropped the lasso neatly about his neck. As soon as the rope was made fast to a stout tree the lizard was ours, and it required only the precaution of roping his tail also, to prevent his damaging anything by its lashings, to enable our coolies to do their share of the work. They now brought their long pole, hog-tied the lizard to it, and carried him triumphantly back to camp.

A special cage had been built for him, and as we thrust him in at one end, we cut the thongs one by one, till he was entirely free but securely enclosed And then came fireworks! Feeling



The long, yellow, protrusible, bifurcated tongue of the varanid lizard is used as a sensory organ

The "rumah" as the natives call it, of *Varanus komodoensis*. The deaf beasts use their long claws to excavate these burrows under rocks and tree stumps, and retire into them for the night

himself at first free, and then confined within four walls, he lashed himself into a great fury, vomiting and giving out such a vile smell that we left him.

There was a large air-hole at the top of the cage, which we had covered with the strongest steel netting that could be obtained in Batavia, yet when we came out the next morning to look at him, we found to our dismay that the wire had been ripped off, and the cage was empty. The twisted steel and the gaping hole were evidence of a strength which we had never suspected. Thus we lost the greatest prize of our expedition. We had felt so sure of him that we hadn't even taken the precaution to photograph him.

We caught many other lizards in our traps, but none so big. The Colonial Government had given us a permit to kill or capture only fifteen of the beasts, so we had to release many of those caught. We were enabled, however, during the process to study the habits of the animals. One evening we released five on the beach to test their swimming ability, and to see whether they would take to the sea of their own free will—an important question with regard to their distribution. Of five lizards let loose, one large and one small one immediately fled to the sea without the slightest hesitation. Two others headed for the jungle, while a third ran down the beach for 150 yards, went up into the grass, and then, after looking the situation over, deliberately proceeded to swim far out into the bay. The largest one which had taken to the water submerged for a full two minutes, and then appeared a hundred yards away, swam down the beach for a half mile, and ambled slowly off into the jungle. When swimming, their heads were carried well up above the surface of the water, so that they could be seen at a great distance, but on the whole, we considered them rather clumsy and ineffective swimmers.

On one point we were greatly disappointed. We found no eggs, nor any trace of them. But as part of a large herpetological collection numbering several thousand specimens we did succeed in bringing out twelve dead and two live *Varanus komodoensis*, sufficient to make an excellent museum group.

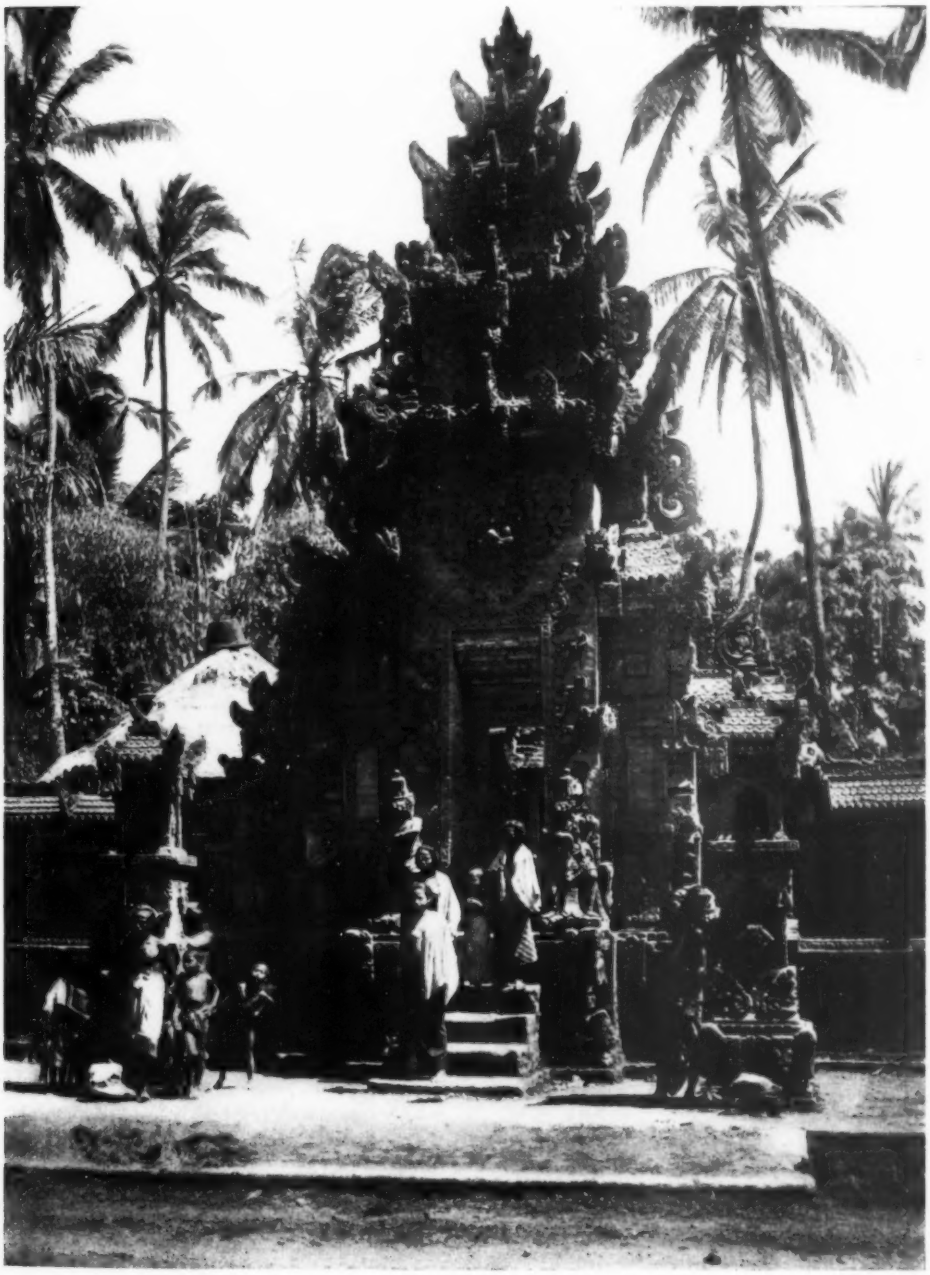
Concerning the place of *Varanus komodoensis* in evolution, it is interesting to note that these varanoid lizards represent the group from which snakes were evolved, which accounts for their snakelike appearance, their mobile head, and long, protrusible, bifurcated tongue.

According to the most recent investigation, it has been definitely shown that *Varanus komodoensis* is closely related to the Australian monitors which gave rise in Pleistocene times to such monsters as Megalania known to have attained a length of thirty feet.

Islands of the East

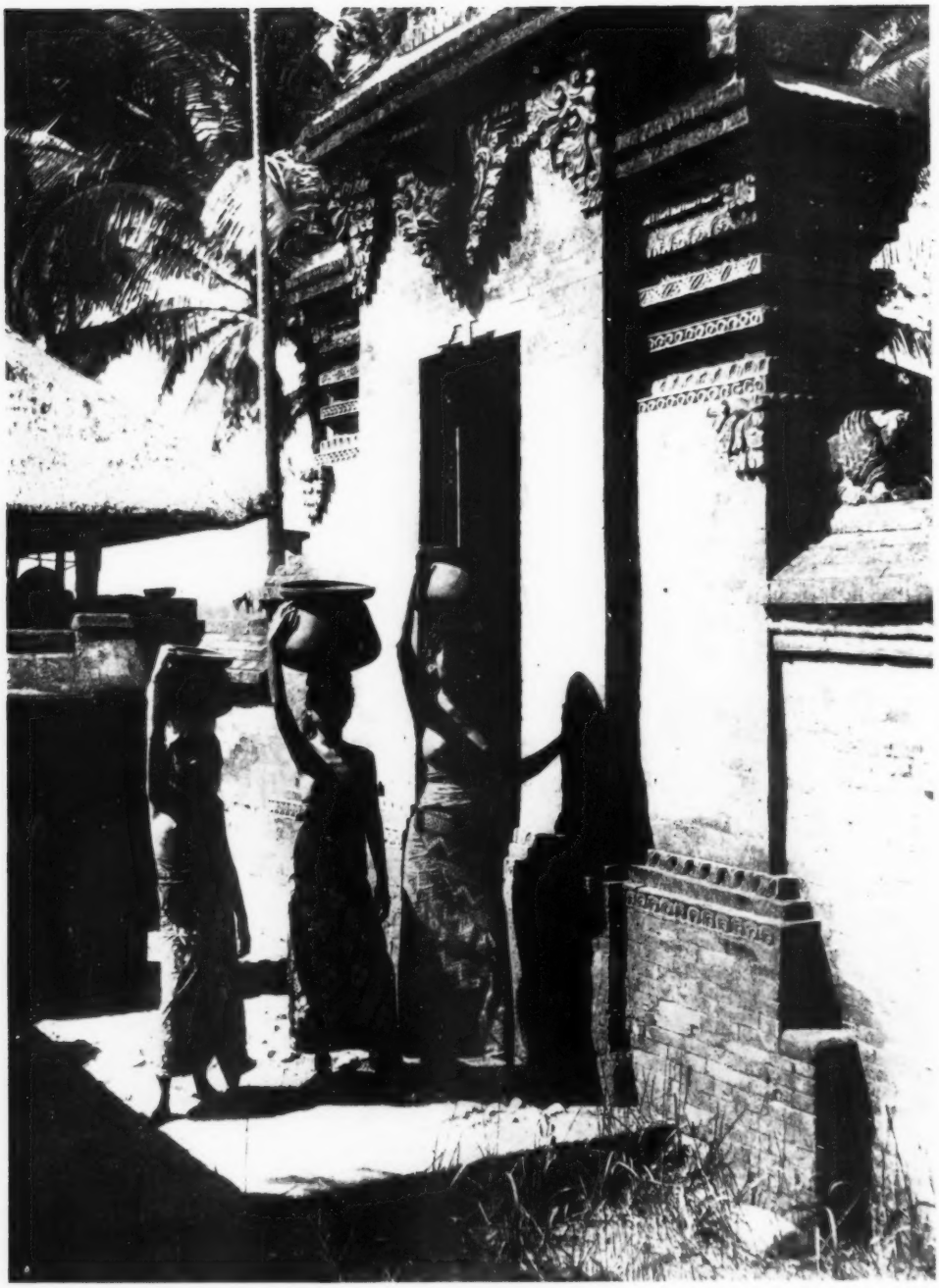
By DOUGLAS BURDEN

A series of volcanic islands which have arisen along the axis of the Sunda fold extend eastward from Java toward New Guinea. These are known as the Lesser Sunda Islands. Although they belong to a single group, the extraordinary differences in the people who inhabit them, and also in the islands themselves, are striking



A HINDU TEMPLE IN BALI

The temple gateways form the most characteristic and prominent architectural features of this beautiful and luxuriant island. Bali and Lombok are the only islands in the East Indies where the Hindu religion still holds sway



BALINESE SISTERS

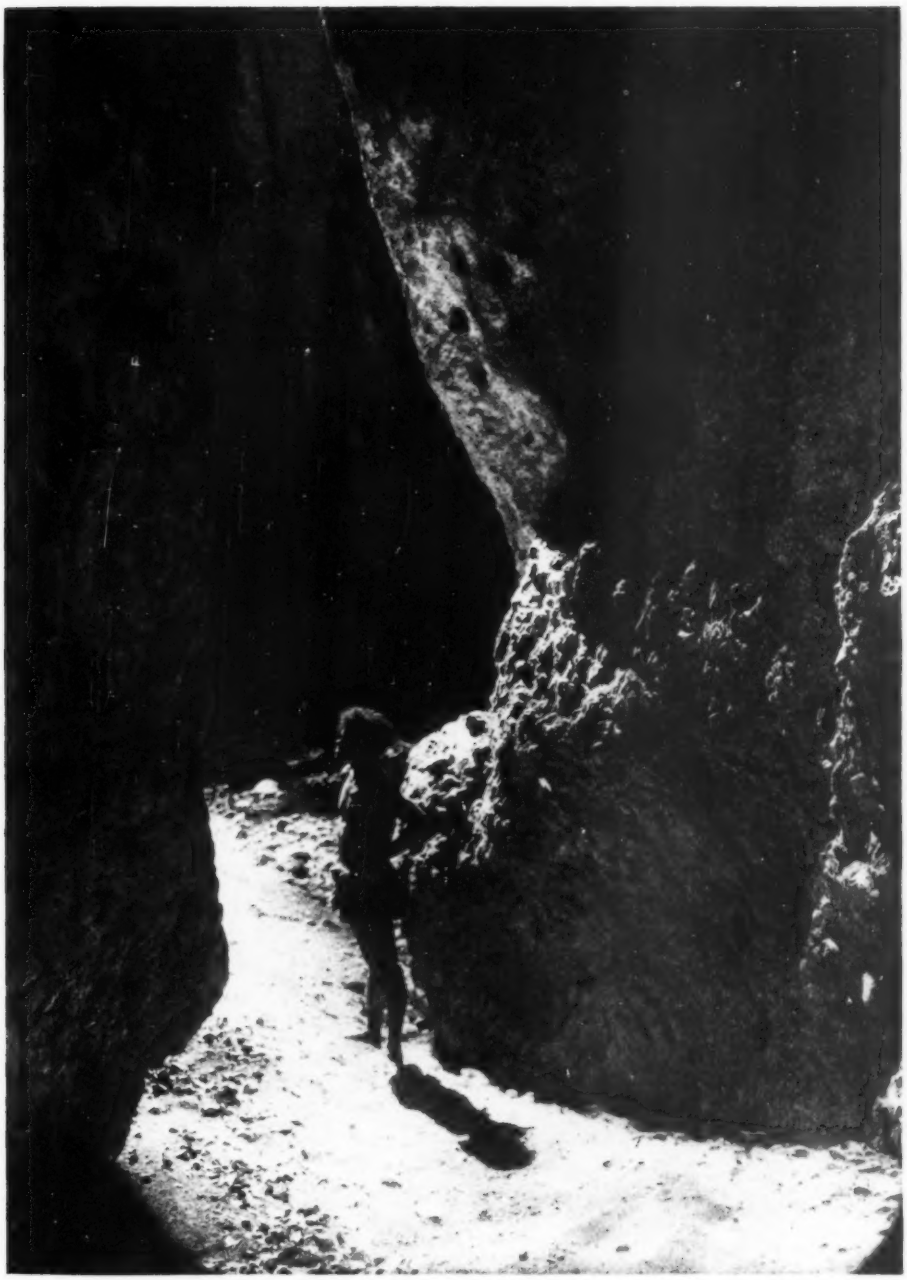
The maidens of Bali possess a natural beauty of form and a lithe grace of movement characteristic of peoples who practice carrying loads on the head. Except for the inevitable sarong, clothes are regarded as a mere encumbrance

BEAUTIFUL BALI

Picturesque doorways where the sunlight splashes through, weird temples outlined against an azure sky, shaded vistas of verdure where it is always cool, and thatched villages nestling in coconut groves are all a part of beautiful Bali, the toyland of the East

A FAMOUS DANCING GIRL OF DEN PASSEAR

The gold headdress crowned with the sacred lotus flower and the gorgeously colored brocade costume form a picture of striking beauty when worn by a graceful Balinese maiden. The dance in Bali is a religious ceremony in which ancient mythological legends are enacted. The little dancer is only ten years old. She has been trained from babyhood, but must cease dancing when she reaches puberty



A CAÑON OF WETTA

The rugged, inhospitable island of Wetta, situated at the extreme eastern end of the Lesser Sunda Chain, is inhabited by Papuans whose primitive culture is in striking contrast with the civilization of the Balinese. No less a contrast with the gentle, luxuriant slopes and peaceful coconut groves of Bali are the mountains of Wetta that have been splintered into a million jagged fragments, and the deep, forbidding cañons cut out of ancient lava flows. These form insurmountable barriers that oppose the travelers' way

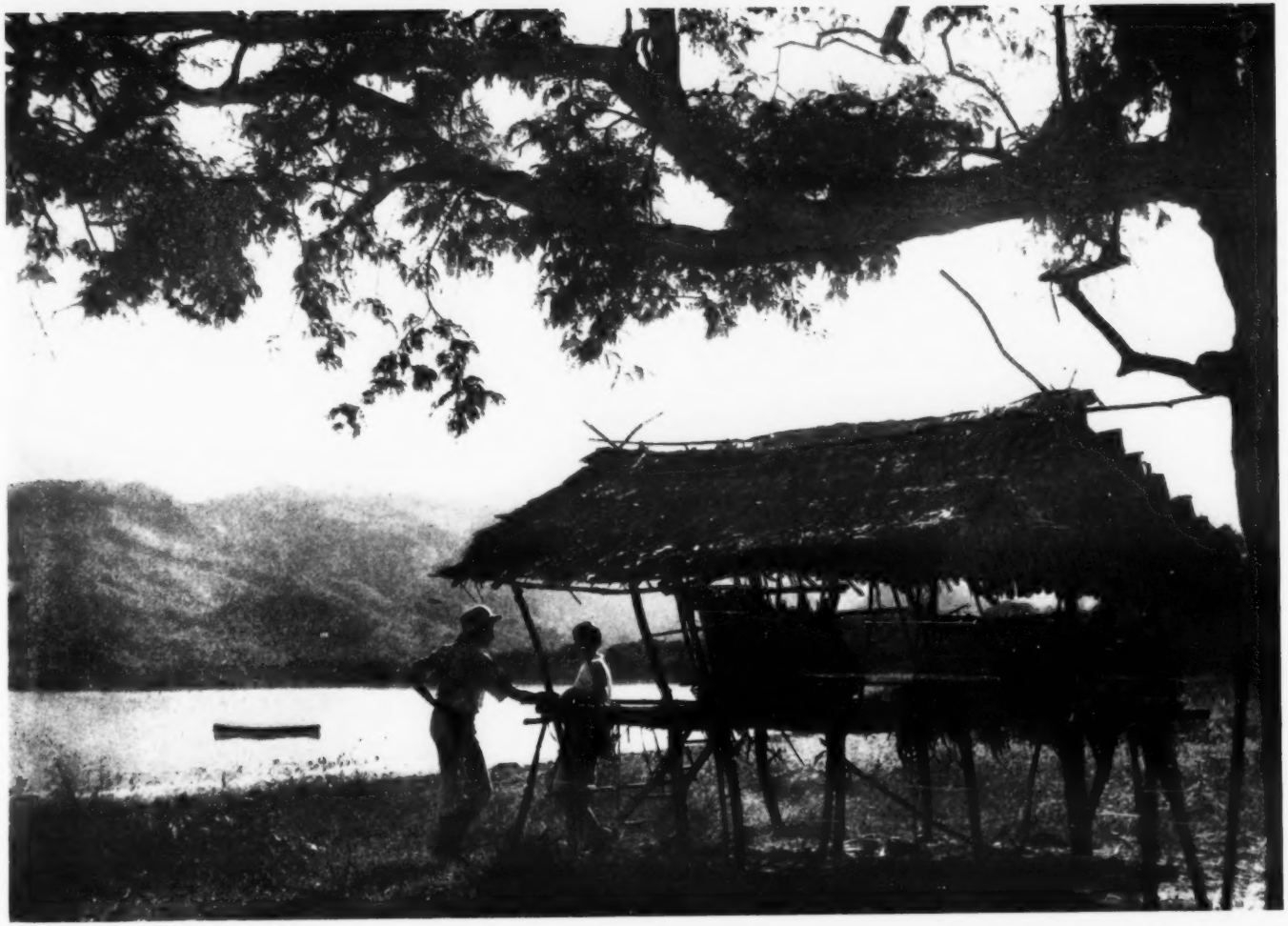
A FINE OLD CANNIBAL

"Livid with skin disease, his teeth gone, his eyebrows arched meanly together, and his nostrils dilated, he stood there on splayed feet, with his long finger-nails scratching among the folds of a tattered hide—as rascally an old savage as ever I hope to see.

"With many gutteral explosions and low rumblings and mumblings, he eventually allowed himself to be pushed into the sunlight, and I obtained my picture."—FROM THE JOURNAL OF THE EXPEDITION

FISHING ON KOMODO

The monsters that swam along the shores of Komodo were of such a size that Mrs. Burden lost nearly all her tackle. Eventually she had to use manila rope and a leader of chain. The above is a large grouper probably *Epinephelus pantherinus* (Lacepede)



HOME

"Our hut has come to bear all the earmarks of a true native home. The whole front of it is open to the sea breeze. The roof of woven palm leaves is mellow and bearded with age, and rattles dryly in the wind. All manner of tangled things dangle from it and sway to and fro, and it harbours the richest assortment of crawling life, including scorpions, centipedes, lizards, and snakes. Only this morning we found a green pit viper in the roof."—FROM THE JOURNAL OF THE EXPEDITION

bearded with age, and rattles dryly in the wind. All manner of tangled things dangle from it and sway to and fro, and it harbours the richest assortment of crawling life, including scorpions, centipedes, lizards, and snakes. Only this morning we found a green pit viper in the roof."—From the Journal of the Expedition

Scanned with CamScanner

Samos, near-by islands, and adjacent Turkish coast. The hatched area indicates fossiliferous Miocene deposits with quarries

Samos—Romantic Isle of the Ægean

By BARNUM BROWN
Curator of Fossil Reptiles, American Museum

"BE IT ENACTED THAT THE GREEK GOVERNMENT PERMITS ANY PART OR ALL OF THE FOSSILS COLLECTED IN SAMOS BY BARNUM BROWN TO BE SHIPPED TO AMERICA AS AN EXPRESSION OF THANKS TO THE AMERICAN PEOPLE FOR THE MANY BENEFITS GIVEN."

This order of the Greek Ministry issued in September, 1924, became a law when published in the official journal, and permitted the American Museum to secure the first collection of fossils ever sent out of Greece intact.

With its wealth of antiquities rapidly disappearing, Greece, in order to retain in the country unique examples of its ancient masterpieces, was long ago compelled to prohibit the exportation of antiquities. The wisdom of this policy is recognized everywhere, for the works of any great artist, or school even, are necessarily limited. Unfortunately the restrictions on "antiquities" have been construed to include fossils, examples of which are usually limited only by the amount of search necessary to secure them. In consequence

Picturesque Vathy, the modern capital, is built around the best harbor of the island. The name Vathy means "deep"

In Vathy, the houses, built on narrow, cobbled streets reminiscent of Turkish occupation, are crowded almost to the water's edge and extend up the mountain-sides

the two great fossil areas of Greece at Pikermi and at Samos are not as generally known as the classic fossil localities in other countries.

Pikermi lies about twenty miles northeast of Athens and a few miles south of the famous field of Marathon. When the courier on "winged" feet sped to Athens with news of the victory of the Athenians and Platæans over the Persians in 490 B.C., he passed within a stone's throw of this celebrated fossil locality.

Samos is probably an unfamiliar name to most readers, yet there are few cigarette smokers who have not at some time burned incense that was grown on this beautiful island, now celebrated for its wine and tobacco as it was in ancient days for wine and pottery.

Although a minor island, it is one of the most fertile areas in modern Greece and is surpassed by none in climate or in beauty of scenery.

Like a tiny dot on the ordinary-sized map, the island lies close to the mainland of Asia Minor, approximately fifty miles south of Smyrna. Actually it is twenty miles in length and eight miles across at its greatest width, the narrow eastern end being separated from the mainland by the narrow strait of Mycale.

Generally its bold cliffs rise abruptly from the sea along almost the entire coast line, and two great mountains, Kerki and Karvuni, rise respectively 4724 and 3730 feet above sea level, with their connecting elevations forming the backbone of the island. This series of heights was elevated when the island mass was torn from the mainland by a great land movement that at the same time deflected the course of the Maeander River of Asia Minor, which once flowed northeastward across the eastern end of the island.

The surface topography is so irregular that on the entire island there are not more than 5000 acres of level land, and most of the vineyards and tobacco fields are picturesque gardens that cling to the hillsides in narrow walled terraces.

Vathy, a modern town of 15,000 inhabitants, is the capital and chief port, snuggled under the hills in a beautiful bight on the north shore. Of the several smaller towns, Tigani, on the south shore, is of chief interest, as it is built on the site of a splendid ancient city, Astypalæa.

The present population of Samos numbers about 65,000, and at no time in ancient days did the population ever exceed 100,000, but what a wealth of historic events cluster about this little island!

Samos was the mightiest state in Greece in the days of Polycrates, and it was a formidable rival of Athens even in the days of Pericles. In the war of independence the Samians were the first Greeks to take up arms and the last to lay them down.

In ancient days Astypalæa was a city of great importance. Its surrounding walls may still be traced and at points still remain entire. Here was a great harbor, the chief source of Samian wealth, for the ancient Samians were a maritime people and they built so well that the mole and harbor are still in use. The three wonders of the city, the mole of the harbor, the aqueduct of Eupalinus, and the ruins of the noble temple of Hera still exist. Between the temple and the city two miles distant, stretched a road bordered by magnificent baths, noble buildings, and the graves of celebrities of the city. The Heræum was one of the largest and richest temples in Greece and was erected in very early times by Rhœcus,

Modern Tigani ("frying pan") built on the ruins of Astypalæa.—The ancient mole and a Byzantine fortress guard the sea face. The arrow points to the Heræum

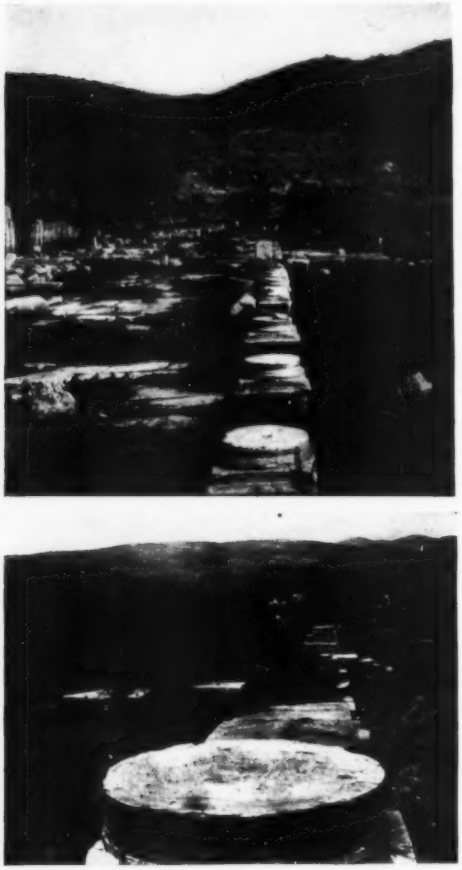
Along the hilltop, marking the outer limits of the citadel, the huge Cyclopean wall still stands, in some places entire, defying the elements as it once did the enemies of Astypalæa

A monument to its departed glory, a lone column of the Heræum still stands, its drums askew from earthquake shocks

or by Rhœcus and Theodorus. Like Artemis, Hera was the mistress of the moon, and like Persephone she ruled the springing up of the crops. She was also goddess of marriages.

The Heræum and the aqueduct which brought water from distant springs, part way through a mountain, have been excavated, but the wonderful old city has been only partly exhumed and still contains a buried wealth of historic data. A small museum in Tigani holds some choice Greek and Roman figures, one a rare example of archaic sculpture showing Egyptian influence.

Of the celebrated characters in ancient Greek history Samos produced Rhœcus and Theodorus, archaic workers in bronze; Pythagoras, mathematician and astronomer, driven from his home by the tyranny of Polycrates; Mandrocles, who built the bridge of Darius over the Bosphorus; Timanthes, the great painter; Assius, the poet; and Durus, the historian.



Bases of outer columns along the sides of the temple of Hera

Many pages of Samos' history have been lost, for the island was frequently the pawn of more powerful communities and was at least twice completely depopulated during historic times. Its first inhabitants were descendants of the Pelasgians, but its true founder was Ancee, King of the Leleges, who settled there with the Cephalonians and the Ionians. He planted vineyards and built the city of Astypalæa in memory of his mother.

One of the most famous men of olden times was Polycrates, who reduced the Samians to slavery, but the tyranny of Polycrates brought Samos to its highest point of external prosperity about 536 B.C. He was the inventor of the Samian war galley.

After the death of Polycrates, Samos passed into the control of the Persians. Aeces became tyrant of Samos, and between 404 and 439 B.C. was succeeded by Theomestor, who was set over the island by Xerxes as a reward for his bravery at the battle of Salamis. He was ruler at the time of the battle of Mycale, where the Samians contributed not a little to the victory. During this period, Samos shipping was famed in many seas.

Alternating between the rule of Athens and Persia several times, the history of Samos, like that of all Greek communities, is a continuous record of factional fights between the aristocrats and the democrats. During the long wars which followed between the successors of Alexander, history has little to say of the fate of Samos. During the early Roman conquests the Samians suffered severely. The island was captured by pirates and the temple of Hera was despoiled and destroyed. In 129 B.C. Samos was reduced to a Roman province along with the cities of Asia Minor. Proconsuls and pirates pillaged it in turn and all of its wealth was carried away.

Up to the time of Vespasian, Samos retained nominal independence under all of the emperors, but in 70 A.D. it definitely became a Roman province

and until the eighth century Samos was forgotten. The Turkish Tzachos owned it at the end of the eleventh century, then it passed successively into the hands of the Venetians, the Pisans, and the Genoese, and was made a part of the Latin empire in 1204.

In 1453 it finally fell into the hands of the Ottomans. The population visibly decreased and when the last of the Samians had emigrated the island became a mere rendezvous. It was repopulated under Kilijd Ali by people of different islands, and upon his death in 1587, was returned to the Sultan. From this period until the war of independence there was nothing notable in the history of Samos. Through the great European powers, France, England and Russia, Samos in 1835 begged for and obtained from the Sultan Mahmoud an autonomous government. From that time until 1912 Samos was subject to the Porte, after which it came under the Greek government.

So much for the history of Samos.

It is a curious fact that whereas numerous passages are found in the works of ancient authors which prove their knowledge of the presence of fossils on the island of Samos, one does not meet with a single trace of this in modern writers until comparatively recent times. Euphorion recounts in his writings the fact that the island of Samos was inhabited in olden times by wild animals of gigantic size, called naiads, the bones of which still existed in his time. Two natural phenomena had evidently given rise to this myth. The roaring of the naiads which caused the earth to tremble and quake, refers beyond a doubt to the earthquakes which are still frequent in Samos and which were particularly mentioned by some of the ancient authors. The bones of the naiads which existed in the days of Euphorion are without doubt fossil bones. Plutarch, on the other hand, ascribes these bones, which were still to be seen, to the Amazons who had been pursued and slain by Bacchus, and he also adds that the piercing cries were in reality the cracking of the side of Mount Phlion. A Greek physician of Mitylinos, Dr. Achille Stephanides, first identified these bones as those of fossil animals, but they were brought to the attention of the scientific world by Dr. C. J. Forsyth Major, who studied Doctor Stephanides' specimens when he made a systematic collection for the British Museum in 1887 and 1889.

Subsequent to Dr. Forsyth Major's work and previous to the world war, representatives of German and Austrian museums carried on extensive excavations. In 1921 I made a preliminary reconnaissance of the Samian fossil field, locating several favorable spots where bones were exposed. Fine paved roads, built under the Turkish suzerainty, connected many of the villages, but donkeys and a few saddle horses were the only means of getting about.

From Hora northward across the narrowest section of the island, there is a series of sedimentary river deposits totalling nearly a thousand feet in thickness, composed of creamy, buff-colored clays alternating with beds of volcanic ash which are in some places fifteen feet thick. The entire series is unquestionably a river deposit and represents the original course of the Maeander River, now debouching fifteen miles to the south, but which evidently had followed this course before Samos was broken away from the mainland. The village of Mitylinos is near the center of these fossil deposits and is situated at the foot of the

A street scene in Vathy

Threading tobacco leaves on drying poles

Ambelos range of mountains. Along the Potomis stream, several deposits of bones have been located, and frequently where new vineyard or tobacco terraces are being established the farmers uncover them.

In 1923 I obtained a permit from the revolutionary government in Athens to excavate and collect fossils for one year in Samos.

Early one morning in September the trim ship "Muskantha," erstwhile palatial yacht of Egypt's Khedive, nosed along the verdant coast of Samos, and as we anchored in the peaceful Vathy harbor, almost among the buildings, her musical siren echoed and reechoed from every hillside, awakening the famous oracle of the historic isle. There are no trains to break the ennui of island life, but the powerful siren of the weekly mail boat brings farmers from long distances to the port for news.

Many Samians have relatives in America; some have labored there, and I was informed by post office officials that 3000 were pensioners of Uncle Sam. Few speak more than the emphatic words of the English language, but fortunately I secured the services of an excellent interpreter.

What a change had taken place since my last visit two years before! War with Turkey had been disastrous to Greece, and had brought thousands of Greek refugees to the island. Every abode was filled to overflowing, and the steep, narrow streets were busy places. Around the street tables in front of every coffee shop sat groups of people talking politics and the price of tobacco as they sipped their coffee and Oyzo.

Villagers, in national costume, smoking water pipes

Sheep and goats graze the mountain-sides

Christmas day in camp.—This snow was the first Samians had seen in many years. Rarely was there ice on our water buckets during the winter

The tobacco fields of Asia Minor had been devastated, and that year Samos produced several million pounds of the golden leaf. Motor cars now made regular daily trips to the inland villages, and everywhere there was an air of activity and prosperity.

From the inland village of Mitylinos mules packed our camping outfit along the rocky trails to a camp site among the pines. After long search we found a spot level enough for the tents, not far from our first quarry. The natives told us we could not winter in tents because of the heavy rains, but series of drainage ditches defeated their prophecy.

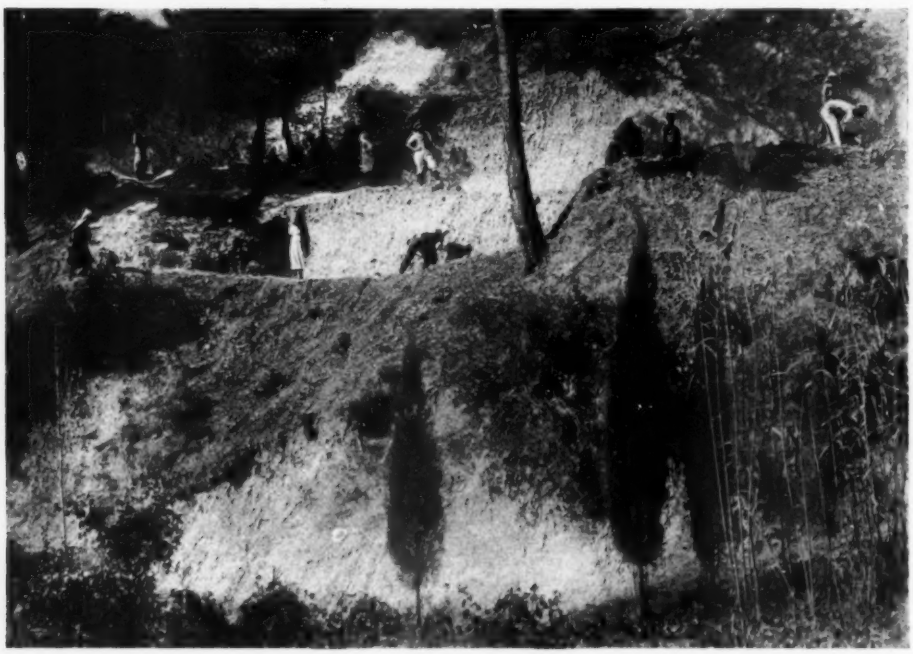
Our advent soon brought scores of refugees seeking employment, and in two days our force was complete, eighteen men digging with picks, and six girls carrying out the dirt in baskets on their shoulders. Our first quarry was a large one, 30 feet long and 50 feet deep, and it took long hours in the quarry to uncover the bone layer before the rains started.

The seasons are very regular in the Ægean, and almost to a day, year after year, the storms start; likewise finish. Two days before our first big storm, countless flocks of geese filled the sky in V formation, migrating in their long journey from the Arctic region to Egypt.

By the time our first quarry was excavated down to the bone layer, about the middle of December, the rains had started, and continued almost incessantly until the middle of March, but rain, snow and winds were not the worst part of our winter, for apparently all the fleas of the island, not already occupied, came to share our quarters.

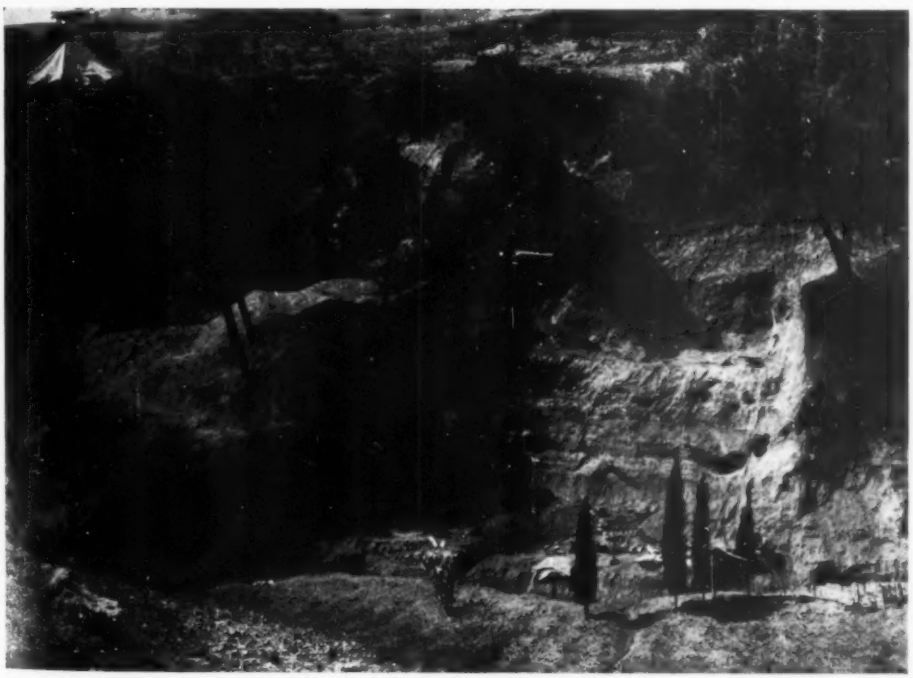
In October the underbrush was aglow with cyclamen; in November the hills were abloom with heather, and

The hillside before excavation was started.—The two men in the stream bed are pointing to the bone layer



Work of excavating Quarry 1 by a series of terraces.—The bone layer is marked by a helmet on the bank

Eighteen refugee men loosened the clay with picks, and six women carried it out in baskets on their shoulders



Quarry 1, 60 ft. long, 25 ft. into the bank, 50 ft. deep. Old German quarry shown at left, workmen's tent above

The climate of Samos is similar to that of southern California. Wild flowers grow in greatest profusion. Each day in spring brought forth a new variety of plant or shrub

when the rains ceased, each day of spring brought forth a variety of wild flowers, in color and profusion surpassing any I have seen elsewhere in an equal area.

The people of the island live huddled in villages, reminiscent of ancient days when individual safety depended on numbers. Early spring sees them climbing the stony trails out to their little terraced fields, each followed by his milk goat. They go to cultivate their vineyards, small patches of tobacco, and their meager gardens of tomatoes and beans. It is difficult to wrest a living from these rocky hillsides where there is no pasturage for cattle; hence meat is a luxury in the island diet. Bread, beans, olives, and goat cheese, washed down with native wine, constitute the daily menu of the farmers, who are content with a bare living.

Different was the lot of our quarrymen, destitute refugees, many of whom had been prosperous farmers in Turkey. They were thankful to have escaped with their lives, and eager to work in the quarries. Current wages on the island were low, but the attractive sum of 35 drachmes (70 cents) per day for the men and 20 drachmes per day for the girls secured the best workers. During their working day of ten hours they had four rest periods for eating and smoking.

A large tent was supplied for the community dwelling of the men; another for the girls, most of whom had never been away from home before.

Our camp in the fragrant pine grove was a Mecca for curious villagers, who were astounded at the ingenuity of the "Americanos" who could build buffet, table, bureaus, and chairs out of ordinary packing boxes. Our stove, the only one on the island, always brought forth ejaculations of "Oh

Encasing individual specimens and blocks of fossils in plaster of Paris jackets.—Quarry 1 was a faulted area with fossils at the closed bank side 6 feet lower than those on the exposure

At the end of the season, large blocks, too heavy for pack horses, were carried down the narrow, rocky trails by men

Papa" and "Oreo." Turkish coffee and sweet crackers were a climax to these visits, after which they would wander homeward laden with empty cans, bottles, and old newspapers.

Such luxuries as canned foods could not be found on the island and had to be shipped from Athens. The weekly trip to Vathy, a day's journey of eight miles by mule, brought fresh meat, potatoes, and the welcome mail from distant parts.

When the rains ceased, quarry work was resumed and a large series of fossils was collected from the six quarries that were excavated during our year's work on the island.

Transporting the large blocks from the hills for several miles along narrow rocky trails presented unusual difficulties, as many of the large specimens had to be carried on poles by groups of men in tandem.

The fifty-six large cases of fossils secured comprise skulls, jaws, and partial skeletons representing three species of three-toed horses, rhinoceroses, chalicotheres, many species of antelope and gazelle, samotheres, birds, and a variety of carnivorous mammals, a fauna that was contemporaneous with that found at Pikermi, Greece, and at Maragha, Persia, of Pontian Upper Miocene age.

Our chief diversions were visits to the fascinating ruins of Tigani, and the picturesque monasteries high up in the mountain fastnesses, where we were always welcome. From the eyrie balcony of the Monastery of Uranda we could look across to the hills of Ephesus, where St. Paul preached to the Ephesians, and visualize the stirring events that have marked the vicissitudes of this little island during the history of the ages.

Ephesus:—Amphitheater with view of small agora to the right and road leading to the marble-lined harbor, indicated by the arrow. The cross marks the hill on which St. Paul was imprisoned

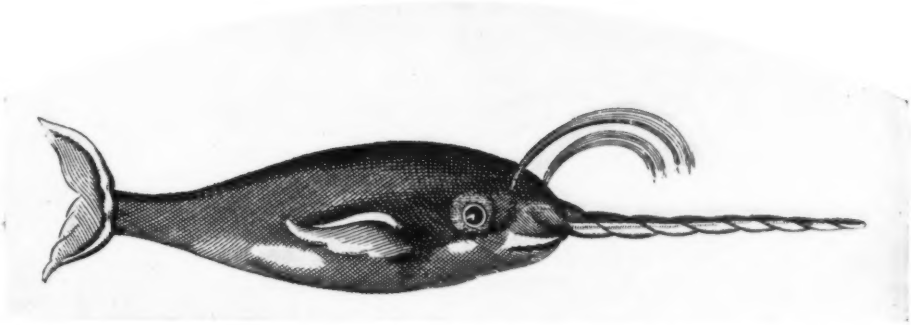


Fig. 1.—One of the earliest pictures of the narwhal or "*Piscis Monoceros*" as figured by Francisci Willughbeii in 1686 as plate ii of his *Historia Piscium*

Northward for Narwhal[1]

By H. C. RAVEN

Associate Curator, Comparative and Human Anatomy, American Museum

And there we hunted the walrus,
The narwhal, and the seal;
Ha! 'twas a noble game!
And like the lightning's flame
Flew our harpoons of steel.
—Longfellow.[2]

IN the middle ages a person setting out to hunt the "mighty Monoceros" probably would not have known in what direction to go, also he might have looked for some terrestrial beast; an animal with the form of a horse, the tail of a lion, cloven hoofs, and a long, straight, spirally twisted horn protruding from its forehead. Such a fabulous creature was made the supporter of the arms of Great Britain by James I.

However, as early as 1655, the naturalist Wormius showed that the long, straight, spirally twisted tusk, so often figured as the horn of the unicorn was in reality the tooth of a small whale, which lived in the ice-bound waters of the north Atlantic Ocean. At one time it was common in the seas about Iceland and Greenland, and was named "narwhal" or *corpse whale* by the Icelanders on account of the pure white coloration of very old individuals.

Eric the Red visited Greenland about the year 983 and soon afterward started a Norse colony on the southwest coast. Certainly these Norsemen must have found the narwhal in Greenland waters, though we have no records of their doing so, and probably they had known of it about Iceland for ages before they reached Greenland. Even so, I believe the ancestors of the Eskimos were very likely the first people to hunt this remarkable mammal.

The Eskimos with the kayak, a completely decked-over canoe evidently evolved for hunting the sea animals, were able to encounter rough water without fear of being swamped, and could sit warm and dry on a fur rug in the bottom of their tiny seagoing craft as they hunted the narwhal.

Early in 1926 Mr. George Palmer Putnam organized an expedition to Greenland of which he was the leader.

[2]From "The Discoverer of the North Cape," quoted by Colin Matheson, 1927, in "Sea Ivory of Old Wales." *Discovery*, VIII, No. 85, p. 10.

[1]Photographs by H. C. Raven

Fig. 2.—The arrows indicate the route followed by the American Museum Greenland Expedition of which Mr. George Palmer Putnam was leader

One of the purposes of this expedition, known as the American Museum Greenland Expedition, was to obtain specimens of the narwhal for exhibition in the Museum's new Hall of Ocean Life. The expedition left New York the latter part of June and reached Holstenborg, Greenland, early in July. The latter part of July found us much farther northward, at Cape York, where we first met the Polar Eskimos. Here, too, we first heard that narwhal were near by, and we saw parts of these animals which had been slain by the Eskimos, though we saw no living ones.

A few days later the "Morrissey" was going at half speed among the icebergs near Northumberland Island on

Fig. 3.—Parker Snow Bay, North Greenland, where the American Museum Crockerland Expedition spent the winter of 1915-1916. On the cliffs to the right, light patches indicate the nesting site of hundreds of murres and kittiwakes, while on the left, water from the glacier tumbles over the moraine

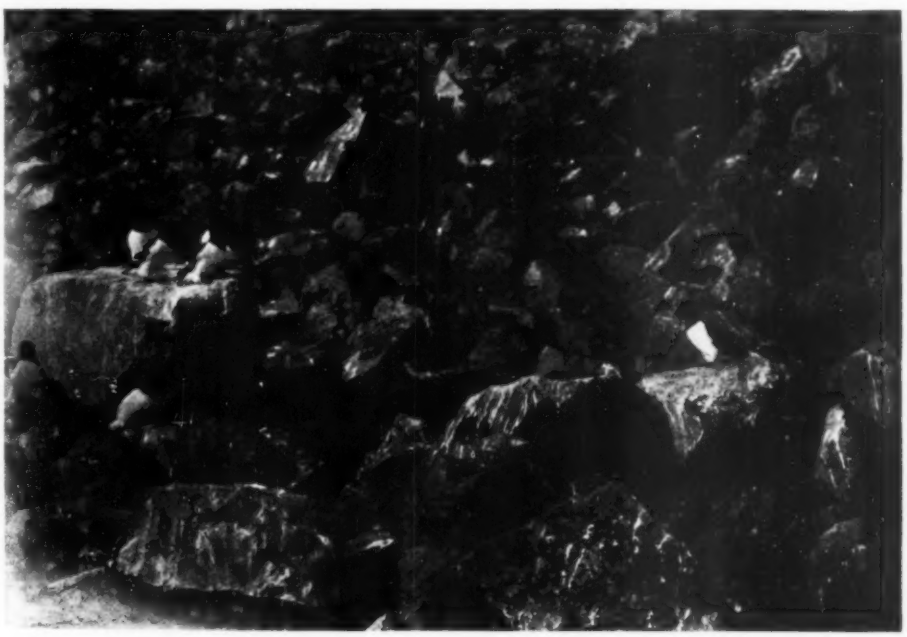


Fig. 4.—Dovekies or little auks, nesting on the talus slopes at Parker Snow Bay, come in with their throats distended with tiny shrimplike animals which they feed to the young birds down among the rocks

account of the dense fog. Thousands of dovekies, or little auks, flew and swam and dived near by, feeding on the countless invertebrate animals, and carrying countless others as food to the young dovekies which were secreted among the rocks on talus slopes of neighboring islands. Through the fog one of our party spied the body of an animal floating at the surface of the still water. A moment later a dory was put over and we learned that it was the body of a narwhal. It may have been dead several months, but the icy waters had prevented its decomposition. This specimen was not perfect externally, but its skeleton was as good as that of any other. Most interesting of all was the discovery that this adult female contained a foetus that was just about ready for birth at the time of the mother's death. The foetus was more valuable than the adult, consequently it was embalmed entire, to be used as the basis for studies on the soft anatomy of this whale which, on account of its boreal habitat, few anatomists have had an opportunity to examine.

I remember very well the night we arrived at Karna. The fog had cleared; there were beautiful cloud effects about Herbert Island to the westward; the sun was low in the north at midnight, throwing a pale pink glow over the icebergs before us and over the several glaciers on the south side of Whale Sound, the warm light contrasting beautifully with the cold blue of the shadows.

On the north side of Inglefield Bay we found quite a large settlement of Eskimos. Through our friend Dr. Knud Rasmussen, the services of these hunters were enlisted.

The Eskimos said in answer to our inquiries that there had been no narwhal here for several weeks past, that they were all up at the head of Inglefield Bay. This was disappointing news but plans were immediately got under way for two of our party to accompany some of the Eskimo hunters up the gulf in search of the narwhal which were the chief desiderata for the Museum. Supplies for the trip were being gathered and loaded into the motor dory, when to our great surprise and delight, several narwhals were seen coming down the bay. Some of them came so close inshore that they passed between the beach where we stood and the "Morrissey" as she lay at anchor. I saw dozens of narwhals coming along, breaking the still surface of the water. The round bullet-shaped heads were forced upward and forward, and a little puff of spray was flying from each blow hole. The glistening blackish backs were exposed for a moment, and as these disappeared, broad, horizontal flukes spread like wings; then the animals completely disappeared, leaving radiating rings of wavelets momentarily reflecting the light of the midnight sun. The narwhals were not speeding but just quietly moving along in small groups. Most often there seemed to be three or four together. Watching them with the binoculars, I saw the members of a group come almost simultaneously to the surface to blow, then dive and again come up about one hundred yards farther on. Sometimes I could distinguish the tusk of a male just as he rose to the surface. The sky and water reflected a beautiful light, and numberless drifting icebergs formed a splendid background for these sleek cetaceans.

Upon sighting the narwhals, we immediately postponed further preparations for the trip to the head of the gulf. Eskimo hunters arranged

their gear and put out at once in kayaks in pursuit of the quarry. There was no wild haste on the part of the hunters. Each in his slender kayak paddled swiftly and quietly away from the shore in a direction that would soonest coincide with the apparent course of the animals. We on the shore watched intently, expecting to see the Eskimos hurl their harpoons as soon as they neared the narwhals. They slowed down as they approached the spot where ripples on the water indicated narwhals had risen a few moments before. Then they cautiously followed in the wake of the torpedo-shaped beasts, at a speed sufficient to bring them a little closer to the animals each time they came to the surface to breathe. This required infinite patience, skill in handling the kayak, and an intimate knowledge of the animal's habits.

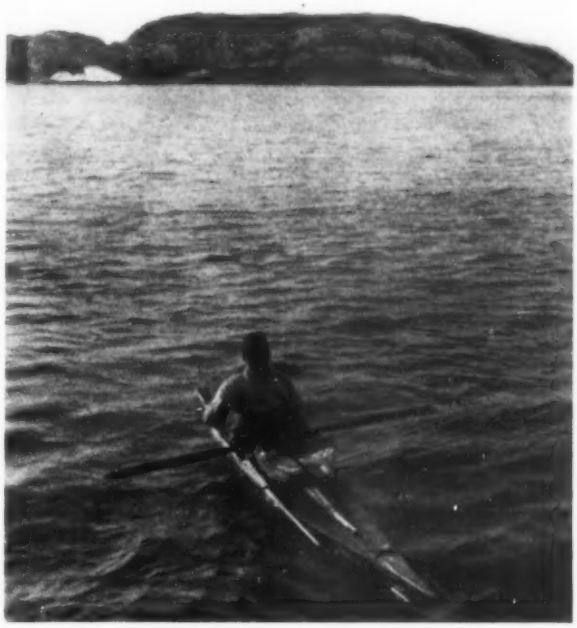
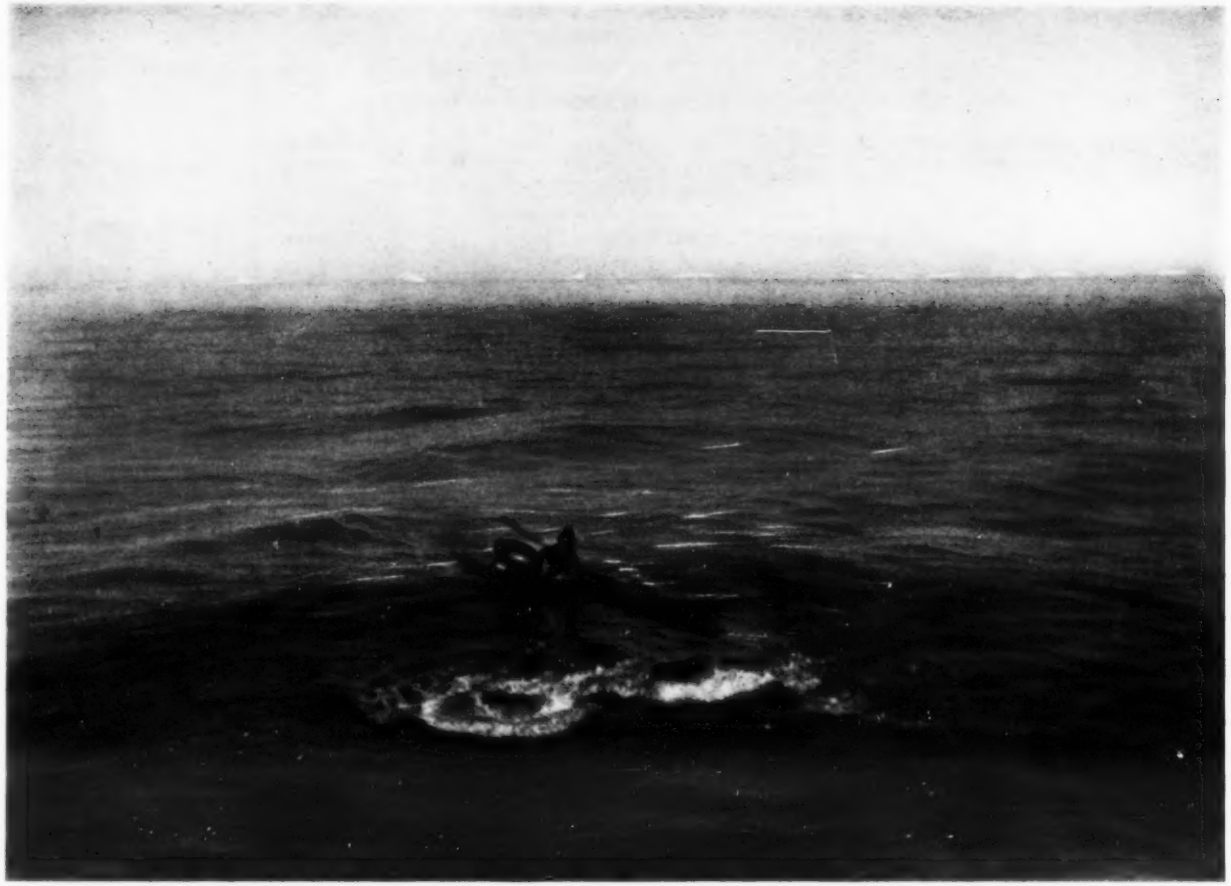


Fig. 5.—The Eskimo hunter sits comfortably on a fur rug in his kayak with his harpoon beside him, its line coiled on the rack before him on deck

After following the narwhals for a time, some of the hunters gave up the chase, as the animals distanced them or changed their course, coming to the surface in unexpected places. On one occasion a narwhal came to the surface just behind a kayak and discovered the hunter. It dived at once, and when it was next seen it was far away, going fast, and still in company with its associates which had all apparently received the alarm signal.

Two of the hunters were successful. A big male narwhal was the first to be harpooned. After following it for a considerable distance, until the animal had come up in exactly the right position, a few feet ahead and to the right of the kayak, the hunter skillfully threw his harpoon with such force that it penetrated several inches into the blubber beneath the skin. As the harpoon pierced his skin he gave a convulsive jerk, a splash with his tail, and disappeared under water. The strong seal- or walrus-hide line, one end of which was made fast to the head of the harpoon, was coiled on a little frame above the deck just forward of the sitting Eskimo. The other end of the line was fastened to two objects: first the float, an entire sealskin inflated, and second, the drag, a shallow boxlike structure with sides of wood and the bottom covered with sealskin. Both were on deck close behind him. In diving, the narwhal pulled the line after him. It quickly uncoiled from the frame, but before all of it had run out, the Eskimo pushed overboard the float and the drag.

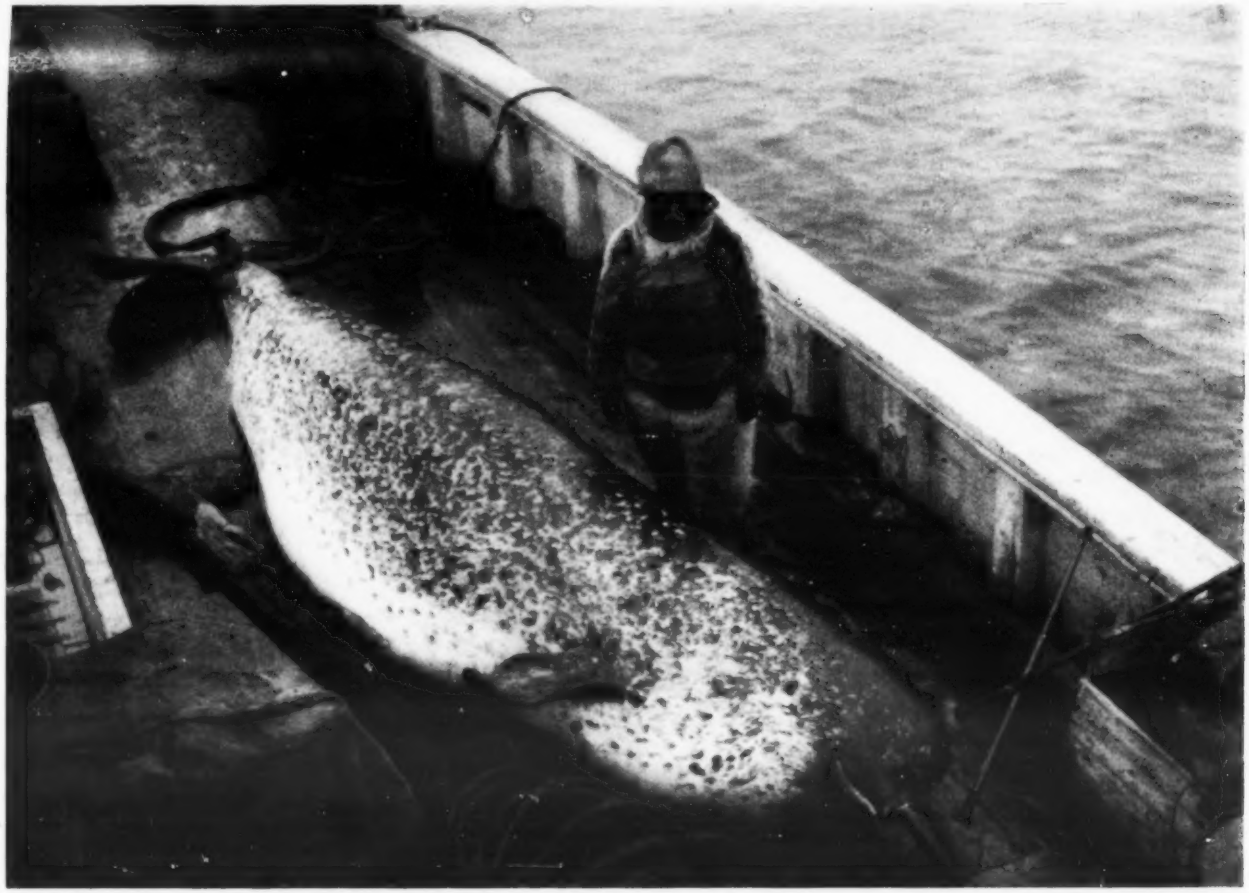
This part of the procedure is espe-



HUNTING THE WALRUS AND THE NARWHAL AT SEA

Fig. 6.—The Eskimo paddles along quietly in his kayak, following his quarry until it rises to the surface in just the right position, a little ahead and to the right; then with agility born of a lifelong training, he hurls his harpoon. A strong seal- or walrus-hide line connects the head of the harpoon with the inflated sealskin float and with a boxlike drag carried behind the hunter

seal- or walrus-hide line connects the head of the harpoon with the inflated sealskin float and with a boxlike drag carried behind the hunter



THE PRIZE NARWHAL OF THE EXPEDITION

Fig. 7.—This large male narwhal measured fifteen feet exclusive of the tusk which protruded five feet nine and one half inches.

The narwhal is the only whale which exhibits a striking secondary sexual character in the form of a specialized tooth.

The function of the tusk has not been determined, but there have been many suggestions as to its use to the narwhal: as a pick with which to break through the ice of Arctic waters; as a spear on which to impale fishes which form its food, and as a weapon to be used in battles between the males. The last seems the most likely, as neither the females nor young have a protruding tusk

cially dangerous, for if the kayak should swing around to the right, or if the narwhal should turn to the left before the hunter was able to push over the drag and float and get clear of them,

Fig. 8.—Heads of male (lower) and female (upper) narwhals. (1) shows the position of the eye; (2) indicates the location of the aperture of the ear, which is just large enough to admit a broom straw

they would certainly be fouled and drag the dusky huntsman to inevitable death.

The whale, with the barbed head of the harpoon embedded beneath its skin, plowed through the water at a great rate, towing the float and drag on a tense and vibrating line. The Eskimo with apparent unconcern paddled along behind. A few strokes brought him to the shaft of his harpoon which had functioned properly, slipping out of the socket in the harpoon head, after expending its force against the narwhal. The kayak was so low that the hunter picked the shaft from the water without even bending down, and placed it with its throwing stick beside him on the deck.

Paddling along in the general direction taken by the narwhal, the hunter soon caught sight of the tell-tale float. He immediately started in that direction. It was perhaps a minute between the time the float bobbed up and the time the animal appeared at the surface to blow. The narwhal came up several times before the Eskimo caught up with it. However, it was not long before the excitement and exertion began to tell on the narwhal. It did not dive so deep, nor stay down so long. The float, of course, indicated what the animal was doing.

The Eskimo inspected his lance as he neared the narwhal, in anticipation of delivering the death blow. The float was up and being pulled along the surface at a lively rate. The hunter seemed almost to move aside to let the narwhal break the surface of the water. Then, with lightning quickness, the little flat-faced man thrust the lance deep into the shining back just between the flippers. There was a great commotion in the water and it looked as though the frail kayak would be crushed by a blow from the heavy flukes. The narwhal dived again but stayed down a very short time. When it reached the surface, frothy blood was pouring from the blow hole and from the wound in its back. Twice more the lance was thrust into its lungs. It floundered, was unable to dive, and after a few convulsive quivers lay still.

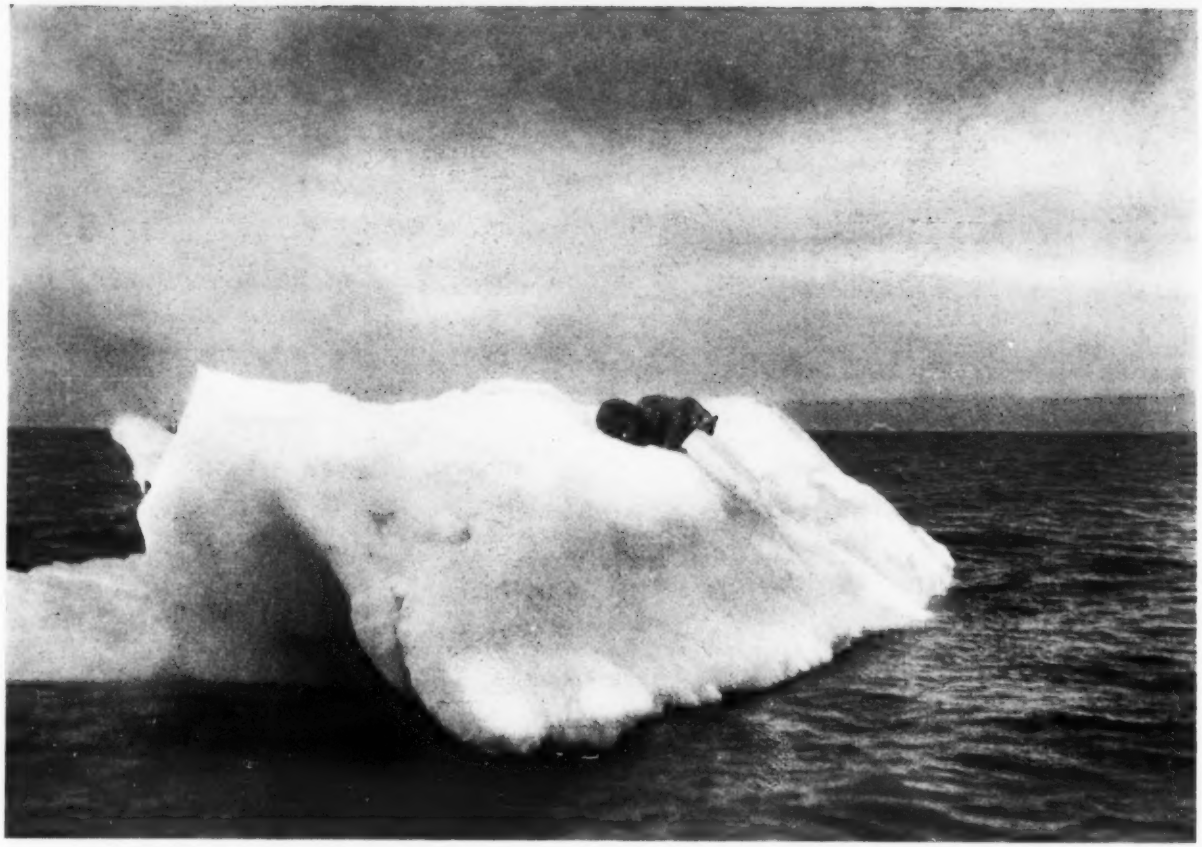
Shortly after the narwhal had expired, another Eskimo paddled up alongside of the first one, then together they tried to tow it to shore, but progress was very slow against the silent strength of the tide. It was very early in the morning, between two and three

Fig. 9.—The Cape York Eskimos lives at the foot of a talus slope beside a great glacier which pushes into the bay. From this point of vantage they are constantly on the watch for animals of the sea

o'clock, when Bob Peary learned that the animal had been killed. With characteristic vigor and enthusiasm he immediately set out in the motor dory with a couple of Eskimos, and about four o'clock he returned, awakened me, and said "I have just brought a big narwhal alongside, a male. The Huskies (Eskimos) have killed another which they say is just around that point to the east. Now we are going after that one,—probably have it here for you in an hour."

As I had turned-in in a hurry, dressing that morning consisted of putting on my shoes and coat, consequently I was on deck in about two minutes. The mate and the two men in his watch were there, too, and there were several Eskimos aboard, plenty of hands to help in getting the prize on deck. A stout piece of rope was made fast around the tail just ahead of the flukes and the "Morrissey's" fore and main throat halyards were hooked into this. After an hour of pulling and hauling we raised the animal out of water and lowered it to the deck.

This fine specimen measured just fifteen feet from the tip of the nose to the notch between the flukes, exclusive of the remarkable tusk which added five feet nine and one half inches, protruding straight out in front from the roof of the mouth. The first thing I did was to make photographs and measurements of it. Later in the day, Mr. Limekiller, taxidermist of the expedition, made plaster molds of all the more characteristic parts of the animal's body, such as the head, flippers, flukes, rudimentary dorsal fin, etc. With the aid of these casts, measurements, and photographs, a very accurate model of the narwhal will be made for exhibition in the Hall of Ocean Life.



POLAR BEARS OF BAFFIN BAY

Fig. 10.—Very early one cloudy September morning as the "Morrissey" sailed southward along the east coast of Baffin Island, the keen-sighted sailor on watch reported three bears on a small iceberg distant about two or three miles. With binoculars it was possible to see a large bear and two small ones. When the "Morrissey" approached the iceberg, the small bears moved about restlessly or stood close beside the mother

Fig. 11.—Shortly after we approached the iceberg on which these bears were, they whined a little and took to the water. Efforts to drive them back on the ice, in order to get more pictures, were futile. They swam a long distance with ease and good speed. Finally the mother bear was killed by Art Young with bow and arrows as a trophy, and the two cubs were roped and captured alive by Carl Dunrad and presented to the New York Zoological Society by Mr. Putnam

Before I had finished measuring this animal the other one was towed alongside and we immediately set about hoisting it aboard. This was a female and of course lacked the projecting tusk characteristic of the male, and was somewhat smaller. The color of these two specimens differed decidedly. The male was almost black along the midline of the back, there was some dark brown intermixed with the black, the sides were mottled blackish and white, the dark color appearing as if it had been put on by the strokes of a brush. The darker markings were fewer on the lower parts of the sides, and the belly was pure white. The female had a little white on the belly but on the sides gray replaced the white, and the still darker markings showed through this. The foetal specimen already mentioned was dark slaty gray all over. I thought the differences in color between the adults was a sexual one. The Eskimos, however, insisted that it had nothing to do with sex, that it was merely a matter of age.

Besides these specimens other narwhals were later secured for us in the same manner by the Eskimos. The total narwhal collection amounts to five adults, a young one probably not more than a few weeks old, a large foetus, an embryo about ten inches long, and skulls of other specimens. Much anatomical material was preserved besides the afore-mentioned embalmed foetus: an embryo in utero, the brain of an adult, the head of an adult male, male and female urogenital organs, a stomach, and flukes and flippers.

The adult narwhal has but two teeth. In the female these are straight, tapering, usually less than a foot in length, as large round as a pencil at the tip, and sometimes more than an inch in diameter at the base; the surface is rough and warty and the teeth are composed entirely of dentine. They remain buried in the upper jawbone throughout life. The right tooth of the male resembles those of the female, the left one (or very rarely both) grows from a persistent pulp and is sometimes more than two inches in diameter at the base and eight feet in length. The largest tusk we secured measured exactly seven feet, of which five feet, nine and one half inches, projected beyond the skin. The tusk of the male narwhal affords the only instance among the Cetacea of a striking secondary sexual character.

At the present time the narwhal along the Greenland coast follow the edge of the ice, that is they keep close to bays which are covered with ice. As the bays of north Greenland freeze completely in the latter part of the summer, some, at least, of the narwhal move southward. They arrive off south Greenland in October or November and leave again to go northward in April.

To judge from my own observations, the food of the narwhal is principally fishes. One of the specimens I examined contained remains of the Greenland rock cod, small flounders, and questionably salmon.

The narwhal is of great economic value to the Eskimo. The Eskimos we met seemed to prize the raw skin, which is about an inch thick, above any other food. They eat the entire outer surface of the animal. The layer of blubber, four or five inches thick beneath the skin, is used for fuel, while most of the flesh is fed to the dogs. The tusk of the males is used in the construction of various implements and utensils and for trade with white men whenever opportunity offers.

What Is Inherited?

THE BEARING OF SOME RECENT EXPERIMENTS IN THE AMERICAN MUSEUM ON THE PROBLEM OF AN ANIMAL'S INHERITANCE

By G. KINGSLEY NOBLE

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HOW can a single cell of protoplasm, such as an amphibian egg, produce within a few days' time such a highly organized animal as a tadpole? No signs of the many structures of the animal are visible in the egg. The processes of heredity and development must be closely interwoven and may well be considered together in attempting to answer the age-old question: What is inherited?

The frog or salamander begins life as a single cell, the fertilized egg. The sperm brings to the egg little besides nuclear matter. Its acrosome, or point, has been formed by the transformation of certain cytoplasmic materials and the middle piece by others. But there is at present no definite evidence that these substances play any part in heredity. The hereditary factors of the male parent are brought in by the sperm nucleus while those of the female are located in the nucleus of the egg. The nuclear matter of both parents is composed largely of a number of bodies called chromosomes. These are now known from the combined researches of genetics and cytology to be the bearers of the determiners of heritable characters. The determiners are called genes. They lie in a linear order along the chromosomes. It is the segregation and recombination of the chromosomes during successive generations which gives the orderly sorting out and predictable regrouping of the so-called unit characters so readily observable in domesticated animals.

The real nature of the gene, however, is still unknown, but the latter has been compared to a protein body. We may liken each chromosome to a laboratory table with a row of chemical reagents, the genes, in bottles along the length of it. In the laboratory of the body cell there are two series of such tables (the chromosomes), one set derived from the female and one from the male parent. Each bottle on every paternal table corresponds in position to one on the homologous maternal table. Usually the reagents may be alike in each pair of bottles, but occasionally something has happened to one reagent or the other and it is found to be a different substance, but one related to that in the corresponding bottle of the other table.

When germ cells are formed at the time of maturation and cell laboratories are produced with only half the number of tables (chromosomes) found in the body cells, it happens by the rules of chance that certain germ cells will have chromosomes with chemicals different from those found in others, for each germ cell after maturation comes to contain some maternal and some paternal chromosomes, one or the other member of each pair of chemical tables just described. The individuals resulting from the fertilization of these chemically different germ cells are equally different. Almost every species found in nature is, therefore, composite, for it includes a number of genetically distinct strains.

It would seem hopeless at first glance

to ascertain the original complement of chemicals in any one individual. Careful breeding experiments of geneticists, however, have disclosed the specific effects of certain genes. The results produced in later generations after one chemical has spontaneously changed into another may be very marked. More often, however, many small and insignificant changes in many parts of the animal's body result from the mutation of a single gene. These changes may be of the same size and extent as the differences which systematists seize upon to define subspecies or species. All the heritable differences ever described in animals have been found when fully analyzed to have been caused ultimately either by changes in the genes or in the whole chromosomes.

A gene, however, is not a substance which will give rise to an organ or a part of an organ. It is the combined effect of all the genes working together which produces any one organ. The genes are the hereditary factors, but they are part of a cell system which acts as a whole. This is well shown in the recent work on sex determination. It is a balance of the genes of one or more sex chromosomes working against those of the other chromosomes which conditions a reaction in the developing egg, resulting later in the development of one sex instead of the other.

The chromosome complex is handed on by cell division to all the cells of the body. As the cells of the skin have the same number of chromosomes (except in certain unusual cases) as the fertilized egg, the question arises: What has determined that they shall become skin instead of remaining germ cells? In brief, what determines the differentiation of cells?

The frog's egg even before fertilization has a certain organization which affects the pattern of differentiation. It has an apico-basal polarity as shown externally by the distribution of the pigment. As development continues and the egg rotates, this polarity becomes the antero-posterior axis of the embryo. Polarity is a phenomenon characteristic of most cells and its occurrence in the unfertilized egg is no more mystical (or better understood) than the same condition in the skin cells. Many investigators have concluded that polarity is inherent in protoplasm itself and is due to the polarization of the ultimate structural particles of the oöplasm. Nevertheless, the polarity may be altered by gravity or other external forces, as Morgan and others have shown.

A second axis in the frog's egg is established at the moment of fertilization. The egg becomes bilateral on the appearance of a gray crescent (caused by the retreat of pigment into the interior) opposite the point of penetration of the spermatozoan. Thus, before the male and female nuclear matter have come together in the act of fertilization, both the antero-posterior and the transverse axes of the future embryo are already established.

Cleavage, or the division of the egg into cells, begins with a definite relation to the first of these axes, but is soon modified by the quantity of yolk present. At the end of cleavage the egg has grown no larger but it has distributed its chromatin as nuclei throughout the egg. The chromatin may have increased in amount by growth, but in some Amphibia the increase is not marked. The cleavage period is one of rearrangement of chromatin as regards the cytoplasm of the egg but not a period of visible differentiation.

Nevertheless, a certain amount of differentiation must have taken place at the moment the gray crescent was formed, for this region now takes the lead in active cell proliferation. It becomes the dorsal lip of the blastopore. The embryo, at the moment this region is beginning to proliferate, is not a mosaic of potential parts. If the region which would become the eye is transplanted into the region which would become the gills of another specimen it promptly develops into gills. As development continues the situation changes. Now when the potential eye is transplanted into the gill region, it becomes an eye. During this short interval of time the potentialities have become fixed. Spemann and his associates have analyzed this problem of fixation further. A piece of the dorsal lip region of one species of newt was transplanted into the indifferent ectoderm of another. Here it asserted itself and formed partly out of its own cells (distinguished by their color), but mostly out of the tissues of the host, a partial embryo. The growing dorsal lip region is endowed with a superior power by which it can organize not only adjacent tissues but even the indifferent tissues of another species of animal into which it has been grafted.

The nature of this organizing influence is not known. But it is important to note that what a cell becomes is dependent as much on the influence of an adjacent part as on its own chromatin constitution. This holds equally true as development continues. The first rudiment of the brain is organized out of the indifferent ectoderm by the dorsal lip tissue, turned in to form mesentoderm. As the brain develops, it produces a pair of optic cups which come to lie under the adjacent ectoderm. Here, in some Amphibia at least, each cup induces a lens to form even out of foreign ectoderm brought by the experimenter into its immediate vicinity. If we call the original dorsal lip tissue a primary organizer, we may well call the optic cup which it forms a secondary organizer, for it in turn has the power of organizing indifferent tissues. Thus, it appears that tissue first organized may become in turn an organizer. Development is a progressive adjustment of cells to surrounding cells.

Most organs are determined long before they appear as visible structures. Organized cells may influence the development of tissues in other parts of an animal's body. Thus, Harrison has shown that the factors which call forth the development of the salamander balancer, that characteristic process on either side of the mouth of the early Ambystoma larva, are early localized in a certain region of the ectoderm. This takes the lead in balancer formation and Harrison suggests that it may possibly affect the underlying tissues by enzyme action. As development continues, the balancer attracts a twig from the mandibular branch of the fifth nerve. If the balancer rudiment is transplanted to an abnormal position it may attract a twig from a more posterior nerve or even from similar nerves in a frog tadpole.

Development is, therefore, a highly epigenetic phenomenon, each part being built up out of the coöperative action of preceding parts. Throughout all the changes of development the original chromosomes, quantitatively divided many times and distributed throughout the body as the most conspicuous part of cell nuclei, are present, giving the distinguishing specificity to each developmental stage. A hereditary alteration in the equipment of genes will give

a corresponding alteration in some or all of the stages of development.

Any stage of development may be affected by the external environment. Genes are present, but only able to produce their effects when certain environmental conditions are present. Geneticists have shown numerous mutations carried concealed by different stocks and only appearing when certain optimum conditions of food, moisture, or temperature are realized. Without suitable environment, no characters can appear. Certain viviparous salamanders regularly produce more young than they can bear. The embryos that happen to be in unfavorable parts of the oviduct never develop beyond a certain point.

The primary and secondary organizers of the developing embryo seem to act by producing an internal environment which stimulates the development of those tissues which happen to lie in the proximity of that influence. The nature of this environment is entirely unknown, for no one has yet succeeded in isolating a part of it distinct from the tissue producing it. As the embryo develops, there arises still a third group of organizing centers. These are the glands of internal secretion and they usually differ from the secondary organizers in that they affect many parts of the body at one time. They are in some ways more satisfactory to study than the other organizers, for their secretion may be isolated as a distinct substance and analyzed chemically.

The glands of internal secretion include the thyroid, the parathyroid, the adrenal organs, the pituitary, the thymus, the islets of Langerhans in the pancreas, and the gonads. Some of these glands consist of two or more parts having very different functions. If an animal should inherit an abnormally large or small gland of internal secretion, it would have a profound effect on the animal's body. The functions of some of these glands may be considered in more detail.

Perhaps the best known endocrine gland in the Amphibia is the thyroid. The hormone secreted by this gland produces metamorphosis. In other words, it causes in a very short time pronounced changes in the skin, skeleton, digestive tract, musculature, sense organs, and behavior. If the thyroid be removed from an amphibian larva no metamorphosis will take place. The thyroid, however, is affected in turn, by other internal "environments." A removal of the anterior lobe (actually posterior in position in Amphibia) of the pituitary prevents metamorphosis; in the absence of this lobe the thyroid fails to function and frequently degenerates rapidly.

The hormone of the pituitary has no effect on metamorphosis except as it affects the functioning of the thyroid. The pituitary has other functions to perform. The anterior lobe has a profound effect on growth and, as shown by Uhlenhuth, the addition of anterior lobe substance to the body of the salamander produces gigantism. Acromegalous men and the ponderous dinosaurs seem to owe their gigantism to their enlarged pituitaries.

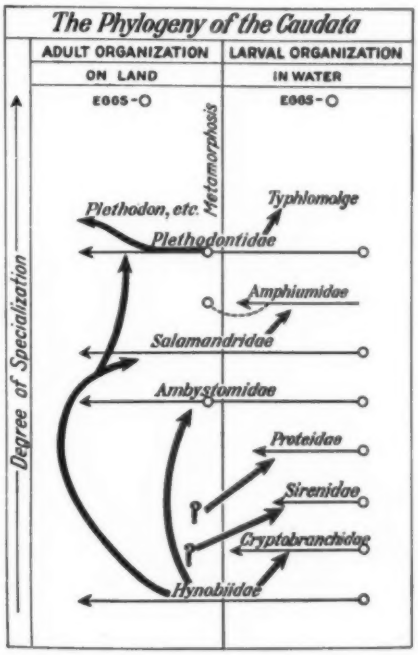
The *pars intermedia* of the pituitary has a totally different influence on the body than the *pars anterior*. Its secretion produces an expansion of the black pigment cells, or melanophores, of the skin, resulting in a darkening of the coloration. A removal of the pituitary results in a contraction of the melanophores and the animal becomes ghostly white. In the normal daily color change of Amphibia the hormone of the *pars intermedia* probably acts

against the hormone from the adrenal organs, for the secretion of the latter is well known to bring about a contraction of the melanophores.

Without attempting to analyze the functions of the other endocrine glands, it is of interest to pass on at this point to animals as they occur in nature. The older naturalists finding such bizarre creatures as *Proteus*, the blind cave salamander of the mountainous region east of the Adriatic, were sure that here was a splendid example of the effect of the environment. "Common sense" made it clear that any animal such as *Proteus*, living in subterranean waterways would have no use for the structures of the land animal, for melanophores or for eyes. The failure to use these structures caused them to degenerate and in time this defect was inherited.

A closer examination of the problem showed, however, that some salamander larvæ of other species, which would ordinarily metamorphose, frequently failed to do so in nature even under environmental conditions which permitted metamorphosis in their brothers and sisters. In these cases the thyroid was found to be deficient in size or structure. This led the Dutch anatomist Versluys recently to examine the thyroids of all the neotenous urodeles, that is, all those groups which never metamorphose. He found some of the genera had actively secreting thyroids while in others the thyroid was apparently incapable of functioning. He concluded that the thyroid of the first group was deficient in the metamorphosing principle, and that all permanent larvæ, including Proteus, owed their neotenous condition to a deficiency of the thyroid.

In the American Museum, however, the problem was attacked by the experimental method. The thyroids of *Siren*, *Cryptobranchus*, and *Amphiuma* were fed to *Ambystoma* larvæ deprived of their thyroids. Within fourteen days all of the animals began to metamorphose, proving conclusively that the thyroids of these forms were not deficient in the metamorphosis-inducing principle. Further, young and old specimens of these same genera, as well as very young larvæ of Necturus, were kept for months in a solution of iodothyrine, known to produce a metamorphosis in *Ambystoma*, but without result. Injection experiments and attempts to metamorphose the very young hypophysectomized *Cryptobranchus* showed conclusively that the



A salamander which has become a permanent larva is merely juvenile, not necessarily primitive. The phylogenetic relation of the permanent larvæ is expressed in the above diagram, which also shows the different developmental levels attained by the various families

FROM NATURE'S LABORATORY

An albinistic permanent larva produced by Nature. *Proteus anguinus*, the blind salamander of Europe, is a product both of its heredity and of its environment, for the latter "molds" what the former provides. This effect of the environment is, however, never transmitted to the next generation

FROM THE MUSEUM'S LABORATORY

An albinistic permanent larva produced in the laboratory: a tiger salamander deprived of its thyroid and pituitary glands early in life. These glandular deficiencies bring the same apparent result that Nature has obtained by the method of mutation

tissues of these permanent larvæ were not sensitized to the thyroid hormone. In some way these urodeles had become immune to the action of their own thyroids.

But, how could such an immunity have been brought about? Immunity as a genetic factor is well known. A change, a mutation in one or more of the genes has made certain laboratory animals resistant to the action of certain diseases. And the same thing has been witnessed in nature. When the plague was destroying thousands of rats and men in the Orient some years ago, there suddenly appeared a strain of rats resistant to the plague. The data at present available seems to indicate that the permanent larvæ owe their neoteny to a mutation of some gene which rendered their tissues nonsensitive to the action of their thyroids.

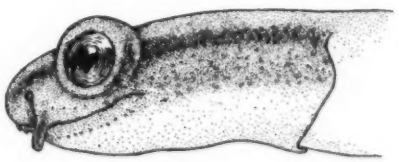
This does not mean that all neoteny is due to genetic factors. Urodeles, such as the axolotl or even the common two-lined salamander, owe their protracted larval period to the nonfunctioning of the thyroid. All urodeles that lay their eggs at high altitudes show a tendency toward neoteny, for the cold waters prevent the thyroid from functioning and the larvæ do not metamorphose. If any of these larvæ, however, have thyroid substance fed to them, or if a sudden rise in the temperature permits their thyroids to function, they will metamorphose within two or three weeks into land animals. It is clear that in this case an environmental factor, cold temperature, is causing, at least for a limited period, the same result as the genetic one in the other group.

Proteus, itself, illustrates admirably how greatly the environment may affect the outward appearance of an animal, covering up, so to speak, the features which are determined by the genes and which would appear under other environmental conditions. If *Proteus* is kept in the light for a time it will become completely pigmented. Each individual apparently inherits a complete equipment of tyrosin or other chromogen base. But its oxidizing enzyme which would convert this into melanin can act only on a prolonged exposure to light. This is different from the conditions in other Amphibia which may become pigmented even in the absence of light. No doubt, all Amphibia contain in their genetic make-up numerous potential characters which are destined never to appear unless special environmental conditions present themselves. In other words, the developmental expression of the same heredity complex may vary with the environment, but in cases where this variation occurs, the heredity complex is not altered in the slightest. It is carried unimpared and ready to produce the more usual results when environmental conditions permit.

In some cases, the result of a genetic factor (but not the factor itself) may be completely reversed by environmental influences. This is well shown in the case of sex reversal where an internal "environment" said by some to be of a nutritional, by others of a hormonic nature, is known to have reversed the sexes of various salamanders, frogs, and toads. A change in the character of the gonads results in a host of changes in the body of the animal. By transplanting a testis into the body of an adult female salamander we have caused cloacal glands, the structures which produce the spermatophores of the male, to develop in the female cloaca. The removal of the testis in the male caused its monocuspid premaxillary teeth to be replaced within

six week's time by shorter bicuspid ones. Most secondary sexual characters are well known to be controlled by secretions from the gonads.

The analysis need not be carried further. It is clear that characters are never inherited as such but appear only after a long series of interactions between the hereditary components and a series of internal and external environments. Heredity gives an animal more potential characters than can ever develop. Environment determines which of these shall appear, but it cannot produce characters which are not provided for by heredity. The actual inheritance of an animal is thus ultimately dependent on the original complement of genes. But what determines the gene complement? Do mutations always arise spontaneously or may the environment cause a change in a gene? The recent work of Harrison on induced melanism in moths, and the work of Guyer and Smith on heritable eye defects in rabbits make it seem possible that under certain conditions a gene may actually be affected by an abnormal environment. But this change is not adaptive, it is rather to be compared with alterations in the chromosomes which have been produced by X-ray irradiations, except that the defect seems to be localized to a single gene. The attack on the nature and mutability of the gene goes forward, but so far it has taught only in regard to adaptations that they are chance associations. Certainly most adaptations, and, so far as our experimental data show, all inheritable adaptations have arisen independent of the environment. Even such highly adapted mechanisms as the "sucking disks" of tree frogs we now know from studies made in the Museum's laboratories to have arisen before some groups of frogs became aboreal and are retained by others which have reverted to an aquatic habitat. Animals make the best of what nature gives them. The blind *Proteus* with its juvenile habitus and deficient pigmentary and optic equipment has sought the only habitat where negatively heliotropic and thigmotactic habits would take a permanent larva. Nevertheless, *Proteus* is a product of its environment, for if it had not sought the caves, its translucent skin would have become densely pigmented. *Proteus* like many other living organisms might have been a far different and, according to salamander standards, a better animal in another environment. What more can be said of Man?



The dwarf salamander *Manculus*.—The elongated teeth and cirrus are secondary sexual characters found only in the male

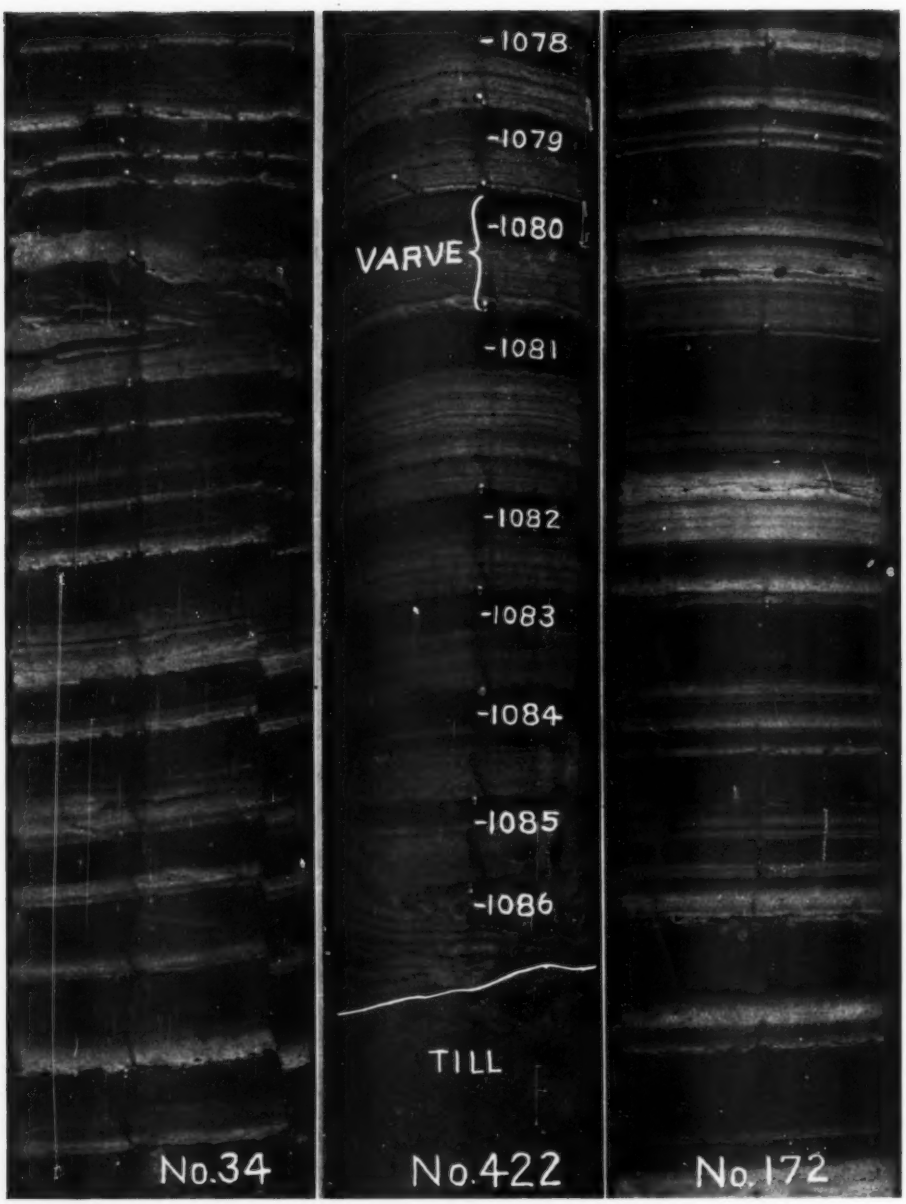


FIG. I. VARVED CLAY FROM THREE GLACIAL LAKE BEDS NEAR NEW YORK CITY

The thick dark bands denote the winter accumulation; the intervening lighter colored layers represent the summer deposition. A pin at the upper edge of each of the dark winter bands marks the limits of each varve. The distance between pins thus represents a varve, or annual deposit.

Section No. 34 contains eighteen varves deposited in glacial Lake Passaic one half mile north of Mountain View, New Jersey. An offset in the layers near the right margin represents a fault; the joining of two dark winter bands in the upper right of the section is due to a lateral slide.

Section No. 422 is a bottom sample taken from clay deposited in Lake Hackensack, one mile north of Little Ferry, New Jersey. The bottom varve (-1086), which rests upon the glacial drift or till, has been disturbed by a slide. The numbers with negative sign represent the author's count of the varves below a datum plane for the Little Ferry district, described in *American Museum Novitates* No. 209, 1926. This section was cut by a special clay sampling tool, at a depth of ten feet, below the lowest working level of the Gardiner clay pit.

Section No. 172 from the Archer pit, Haverstraw, New York, shows nine varves deposited in Lake Hudson. The varves in this sample are thicker than those in the other two samples. Sections No. 34 and No. 172 are gray in tone, while No. 422 is of a pronounced red color. The color of the clays is ascribed to the difference in the color of the underlying rocks, which were scored and scoured by the advancing glacier.

Glacial Lakes and Clays Near New York City

By CHESTER A. REEDS
Curator of Invertebrate Palæontology, American Museum

INTRODUCTION

THE writer's attention was first directed to the need of an exploration of the glacial lakes and associated clays in the vicinity of New York City, on the occasion of the visit of Baron Gerard de Geer and his party to the American Museum of Natural History in the summer of 1920. Baron de Geer[1] came here from Sweden for the specific purpose of examining the seasonally banded clay deposits in the Hudson River valley, from Haverstraw northward, and to compare the time element of the American deposits with the thousands of years which he had established for the deposition of similar clays in Sweden. Since there were no exhibits of such material in the American Museum, or in any other museum in the United States, it was desirable that a series of sections of American clays should be assembled in New York.

The clays are unique in that they are bilaminar for each year (Fig. 1). One lamina represents the amount of "summer" deposition, the other the "winter" accumulation. Taken together, the paired bands constitute a varve or annual deposit.

The clays are of glacial age, since each layer had its origin in an annual retreat stage of the ice of the last glaciation. They were developed as follows: As the ice melted and retreated slowly northward during the warm summer months of each year, the swollen rivers which flowed out from under the ice mass picked up the fine sand and clay particles and transported them to fresh-water lakes which occupied the lower portions of the enclosed basins in front of the glacier. As the stream currents on entering the still waters of the lake gradually lost their power to transport their load of sediment, the fine sand and coarse clay particles settled down over the lake bottom to form the sandy summer layer. During the cold winter months of each year the ice-front became stationary, the englacial and subglacial stream courses either ran dry or congealed, and little, if any, sediments were transported by the rivers into the lakes. The surface of the lake also became encrusted with ice and snow, and the fine clay particles, which had been held in suspension in the milky water following the summer incursions, slowly settled to the bottom to form the bluish, reddish, or dark winter layers composed of pure clay. Before the end of the winter season, the lake waters cleared, and a sharp line of demarcation was established between the top of the "winter" layer and the base of the succeeding "summer" layer. This well-defined line is of value to the collector or student in separating the seasonal layers into varves or annual deposits.

LITTLE FERRY AND HAVERSTRAW CLAYS

In the summer of 1923, the writer, with Mr. P. B. Hill as field assistant, sectioned the clay banks in five pits along the west bank of the Hackensack River in the vicinity of Little Ferry, New Jersey, and brought samples of all of the exposed varves to the American Museum for preservation and study.

[1] James F. Kemp, "Baron Gerard de Geer and His Work," NATURAL HISTORY, Vol. XXI, pp. 31–33.

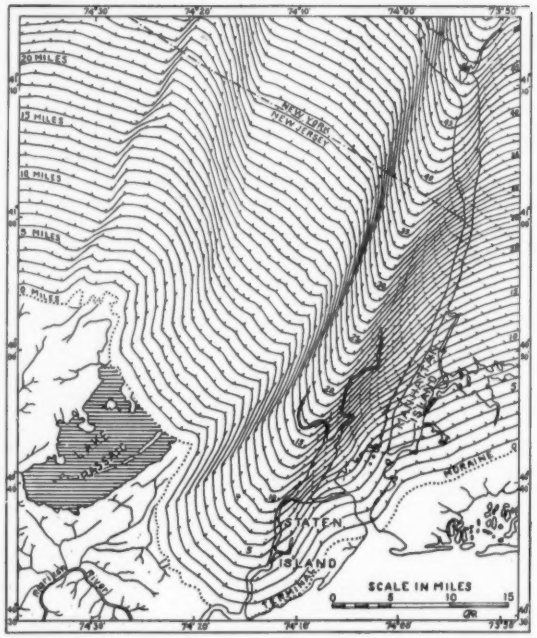


Fig. 2.—Sketch map showing maximum extent of the ice of the last glaciation in the vicinity of New York City; direction of ice advance (dotted radial lines); probable waves of advance and retreat of the ice, measured in mile stages from the terminal moraine; outline of extra-morainal Lake Passaic

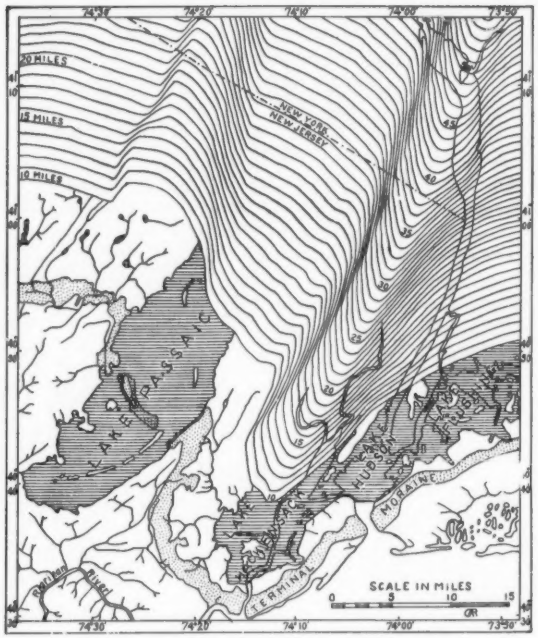


Fig. 3.—Sketch map of the probable position of the ice-front in the vicinity of New York City after having retreated ten miles from the outer margin of the terminal moraine; Lake Passaic well developed; early stage of lakes Hackensack, Hudson, and Flushing

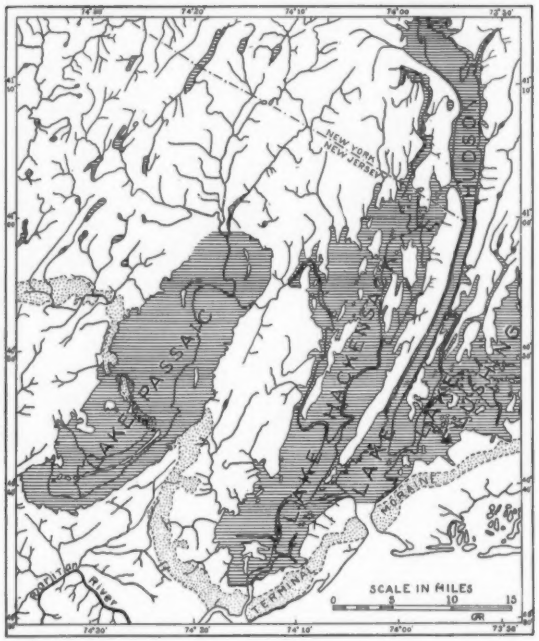


Fig. 4.—Sketch map of maximum extent of glacial lakes Passaic, Hackensack, Flushing, and Hudson in the vicinity of New York City, shortly after the retreat of the ice of the last glaciation. The terminal moraine, present drainage, and smaller glacial lakes are also noted

In the field, varves were found in great abundance in all the pits, but no one excavation contained all of them. A composite section from the five pits[1] gave us forty-five feet of clay and a continuous series of 2550 varves, representing as many years for the deposition of the material as the ice-front retreated slowly northward up the Hackensack valley.

In 1925, the writer, with Mr. Lewis W. MacNaughton as field assistant, sectioned the clay banks in five different pits at Haverstraw, New York, and two near Dutchess Junction on the Hudson. The various banks were not conveniently situated for piecing together a continuous section; however, more than 1500 separate and distinct varves were obtained in the samples procured.

The clay pits near New York City having been sectioned, an entirely different method of sampling the nearby clays was developed and tried successfully in 1926. Open clay pits were seldom worked with steel form and copper tray as in the previous years; instead deep holes of small diameter were bored, followed by an ingenious slicing tool which cut an undisturbed section of the clay and fed it into copper trays, each two feet long. This method made it possible for us to obtain samples in selected places, even the first varves that were laid down on the bottom of the lake (Fig. 1, No 422).

ADVANCE AND RETREAT OF THE ICE

An examination of the map (Fig. 2) will show that the southernmost point reached by the ice of the last glaciation was Prince's Bay, Staten Island, and Perth Amboy, New Jersey. The terminal moraine, which indicates the southern limit of glaciation, is not only well-developed at Perth Amboy, but it extends northeastward across Staten Island and Long Island, and northwestward through Summit and Morristown, New Jersey. The front of the glacier thus assumed a sinuous lobate outline due no doubt to the rather broad open features of the Hackensack valley, throughout the fifty miles of its north-south extent, as compared with the narrow and deep defile of the Hudson River, the major stream, to the east. The Palisade ridge along the east flank of the Hackensack valley, and the Watchung Mountains and New Jersey Highlands along the northwest margin, tended to retard the glacier as it moved southward in those areas. The directions of ice movement, derived from the glacial scratches or striæ, are indicated in Figure 2 by the dotted radial lines. The Hackensack valley thus became the main line of advance of the glacier, and being lower in elevation than the adjacent areas, it contained the greatest thickness of ice.

At the present time no one knows how long the ice-front stood at the terminal moraine; we can merely guess and say several thousand years. Neither does anyone know definitely what positions the ice-front occupied at successive stages of the annual retreat northward. We can assume, however, as a working hypothesis, that it retreated equally along the entire sinuous front. On the map (Fig. 2) the assumed stages, at intervals of one mile, have been indicated, following in reverse direction the same radial lines (dotted) along which the ice is known to have advanced. According to this theory the ice-front at any one position, for example, the ten mile stage (Fig. 3), was very irregular, with the ice-tongue in the Hackensack valley

[1]Reeds, Chester A., 1926, "The Varved Clays at Little Ferry, New Jersey," *American Museum Novitates*, No. 209, pp. 1–16.

persisting after the adjacent highlands had been cleared of ice. Such a working hypothesis is very helpful in attempting to correlate contemporaneous varves in lakes having the same latitude.

GLACIAL LAKE PASSAIC

When the ice-front reached its maximum extent, a glacial lake known as Lake Passaic partially filled the natural basin to the south of the terminal moraine, in the vicinity of Summit and Morristown, New Jersey. Its southern shore followed the recurved basaltic rock of the second Watchung Mountain at an elevation of 345 feet (Fig. 2). The lake waters did not rise above this height, for the Moggy Hollow outlet at the southwest corner permitted the water to flow out into a tributary of the Raritan River and eventually into the sea.

As the glacier retreated northward down the valley of the upper Passaic River, the waters of Lake Passaic followed the ice-front as far as Pompton Plains (Fig. 4), and filled the entire basin lying between the Watchung Mountains and the New Jersey Highlands up to an elevation of 360 feet above sea level. The present lowest point in the lake basin is 160 feet above mean tide, so that the lake during its maximum extent must have had a depth of 200 feet. In some places the shore-line of this glacial lake is faintly preserved; in others it is well-developed, and must have existed for a considerable period. For a detailed mapping of the shore-line and deposits of this well-known glacial lake, one should examine the Passaic and Raritan Folios of the United States Geological Survey, and Volume V of the New Jersey Geological Survey.

As the glacier retreated from year to year, varved clays were deposited in certain areas on the floor of the lake, particularly in low places near where the subglacial streams debouched. The basin has not been fully prospected for glacial clays, but the writer in 1922 observed a few varves close to the terminal moraine in Morristown, and in a clay pit at Whippany. Some four hundred varves, many of which were contorted, were also examined in a clay pit one-half mile north of Mountain View, New Jersey.

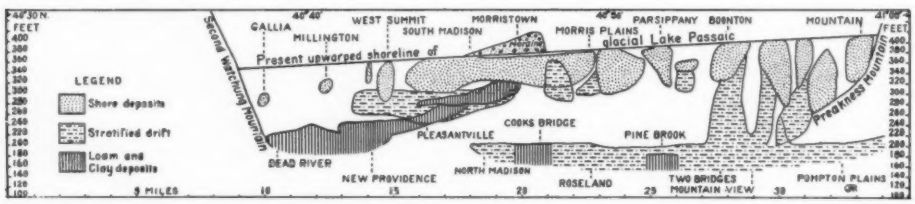


Fig. 5.—Profile drawing showing upwarped shore-line and vertical distribution of the stratified deposits in glacial Lake Passaic. Data from glacial geology sheets of the Passaic and Raritan Folios, U. S. Geological Survey

UPWARPED SHORE-LINES OF LAKE PASSAIC

Since the glacier disappeared from eastern North America, the shore-lines of former glacial Lake Passaic have been warped upward 67 feet (412 feet less 345 feet) more at their northern end than along their southern margin (Fig. 5). The lake had an extent of 30 miles along its northeast-southwest axis, or 26 miles on the meridian. This represents a differential upwarping of the region in the vicinity of New York City, in a north-south direction, of approximately 2¼

feet per mile, or twenty feet in nine miles. This marked change in elevations of the land is known to have affected all the territory occupied by the continental glacier in central and eastern North America, extending from a zero or hinge line in central New Jersey up to approximately 1000 feet to the north of Quebec, Canada. Such differential changes in elevation are not confined to eastern North America, for it has been noted that the glaciated territory of northwestern Europe has been upwarped in a similar manner. Where the relief of the land was affected most, it is believed that the ice was thickest. It was the removal of the load of ice and certain subcrustal or isostatic movements that took place within the earth, that in all probability brought about the changes in elevation.

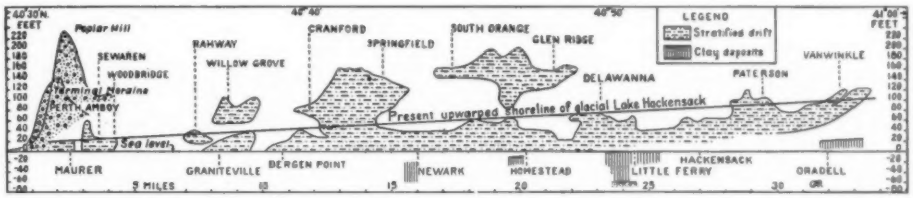


Fig. 6.—Profile drawing showing upwarped shore-line and vertical distribution of the stratified deposits in glacial Lake Hackensack. Data from the glacial geology sheet of the Passaic Folio, U. S. Geological Survey, and the author's field notes

GLACIAL LAKE HACKENSACK

The main lines of railroad that approach New York City from the west, cross the Hackensack meadows just before reaching the Hudson River. No doubt many a traveler who has seen this broad expanse of marsh has asked the question: Why is this? Prior to 1922, when the writer began his investigation on the geochronology of the clays, glacial Lake Hackensack had not been outlined or recognized. The commercial value of the clays, however, had been noted by various state and federal geologists. Twenty to thirty years ago brick yards were established at various points in the northern half of the Hackensack valley but at present all these enterprises have been discontinued except in the vicinity of Little Ferry, where large open pits have been excavated below sea level. To the south of this point the basin is for the most part covered by salt water or salt-water marshes.

The varved clays, however, were deposited in a fresh-water glacial lake and not in an arm of the sea.[1] While the shore-lines of this glacial lake have not been traced in detail in the field, we know the amount of post-glacial upwarping for the Lake Passaic basin, and can apply that data with profit to the Hackensack valley.

Glacial Lake Hackensack, as shown on the sketch map, Fig. 4, was outlined by the writer in 1924, and presented in abstract the same year at the Ithaca meeting of the Geological Society of America.[2] The approximate shore-line starts with the Maurer delta deposit which rises from sea level to 30 feet, inside the terminal moraine less than two miles north of Perth Amboy. With this delta as a bench mark, the 20, 40, 60, 80, 100, and 120 feet contour lines on the topographic maps were followed for nine miles each, the

[1]Antevs, Ernst, 1925, "Condition of Formation of the Varved Glacial Clay," *Bull. Geol. Soc. Amer.*, Vol. 36, pp. 171–172.

[2]Reeds, Chester A., 1925, "Glacial Lake Hackensack and Adjacent Lakes," *Bull. Geol. Soc. Amer.*, Vol. 36, p. 155.

last one of which encompasses the northern end of the Hackensack valley. The reason for changing contours every nine miles is that the amount of post-glacial uplift of the ground averages two and one quarter feet per mile, or twenty feet in nine miles. Lake Hackensack as thus outlined contains not only a number of ridges as islands, but also the glacial clays and the stratified sands, gravels, and delta deposits which rise to successively higher and higher elevations in passing from south to north.

Fig. 7.—Varved clay of Lake Hudson smoothed for sectioning, Washburn and Fowler clay pit, West Haverstraw, New York

The glacial clays which occupy only the lowest levels are reported in deep wells in south Newark; at Homestead the top of the clay is 10 feet below sea level; at Little Ferry approximately at sea level; at Oradell about 15 feet above; at Norwood 30 feet above; and at West Nyack 50 feet above tide.

The delta deposits and stratified sands and gravels, which occur at such discordant elevations that heretofore they have baffled explanation, also rise to higher and higher levels in going northward. For example, the delta deposits in North Hackensack occur at an elevation of 40 to 50 feet above sea level, while farther to the north the sandy delta plains in the vicinity of Tappan rise from 60 to 80 feet above sea level. To show the vertical relations of the various stratified deposits, as mapped on the glacial sheet of the Passaic Folio, to the newly outlined shore-line of Lake Hackensack, and the relation of similar deposits in Lake Passaic, Figs. 5 and 6 are presented. It is surprising how well these varied deposits fall in below the shore-lines in both lakes. The exceptions in the Hackensack valley are the deposits at Willow Grove, Cranford to Springfield and South Orange to Glen Ridge, which occur at higher elevations, and which were in all probability deposited not in Lake Hackensack, but in small lakes which lay at higher elevations hemmed in by early retreat stages of the ice-front and the back slopes of the terminal moraine and of the Watchung Mountains.

GLACIAL LAKES HUDSON AND FLUSHING

The same bench mark and methods of induction and deduction that were used in establishing the outline of Lake Hackensack were applied to the territory immediately to the eastward of the Hackensack basin and northward of the terminal moraine. The results of this endeavor, as noted on Figs. 3 and 4, give us the suggestive outlines of variously connected bodies of fresh water which we have designated as Lake Hudson and Lake Flushing. Varved glacial clays are not known to be exposed above sea-level in Lake

Hudson south of Haverstraw, New York. There and to the northward they are well-developed, at, below and above sea level (Fig. 7). In Lake Flushing, they have been noted by Dr. E. Antevs[1] in the valley of the Quinnipiac River at New Haven, Connecticut, and reported at Fishers Island farther eastward in Long Island Sound. Logs of various wells in Brooklyn and to the eastward yield records of clay lying below the overlying sand and gravel beds.

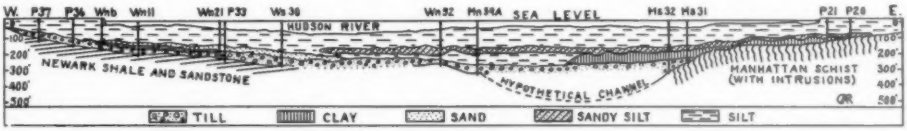


Fig. 8.—Cross-section of the deposits in the Hudson River, developed from exploratory borings for the Pennsylvania railroad tunnels, Thirty-second Street, NewYork City. (After G. S. Rogers)

In New York City blue clay was encountered in 1925, by the engineers of the New York Central Railroad in test borings on the right of way at the foot of West 14th Street, 44 to 72 feet below sea level. Blue clay has also been found in borings along the east bank of the Hudson River off West 10th Street at 98 to 162 feet, and off West Houston Street at 92 to 128 feet below sea level. The exploratory borings for the Hudson River tunnels of the Pennsylvania Railroad also revealed the presence of extensive beds of clay immediately overlying the basal till in the filled channel of the river at depths of 175–200 feet on the west side, 125–175 feet on the east side, and 200–275 feet in the east central portion (Fig. 8). Clay is also reported overlying morainal material in the bottom of the filled East River channel. Since the relation of these submerged clay deposits to the underlying till is similar to that found by the writer at Little Ferry in the Hackensack basin, he assumes that they are banded and of glacial origin.

[1]Antevs, Ernst, 1922, "Conditions in New England During the Deposition of the Varve Clay," Amer. Geogr. Soc. Research Series No. 11.

POST-GLACIAL STRATIFIED SANDS

The varved clay deposits at Mountain View in Lake Passaic are overlaid by some five to ten feet of stratified sands. This is also true at Little Ferry in Lake Hackensack where beds of sand 5 to 20 feet in thickness overlie the varved clays (Fig. 9). At New Bridge, near the west bank of the Hackensack River, and at Oradell, gravel 5 to 20 feet in thickness appears above the clay deposits. At Haverstraw in Lake Hudson, and at points northward, beds of sand and gravel, varying in thickness from 2 to 25 feet, rest upon the varved clays (Fig. 10). The stratified sands at Croton Point, Harmon, and Peekskill are very thick and rise to elevations a little over 100 feet, the approximate position of the shore-line of Lake Hudson at these places. They represent delta deposits made in the lake. Sandy varves about one foot in thickness, observed on Croton Point in borings made near sea level, indicate late glacial age.

Contractors, who have erected buildings on Manhattan Island, know that the southern one-third of the island and the Harlem and Dyckman sections are for the most part covered by stratified sandy deposits, which vary in thickness from a few feet to 100 feet. In the Subway excavation at 134th Street and

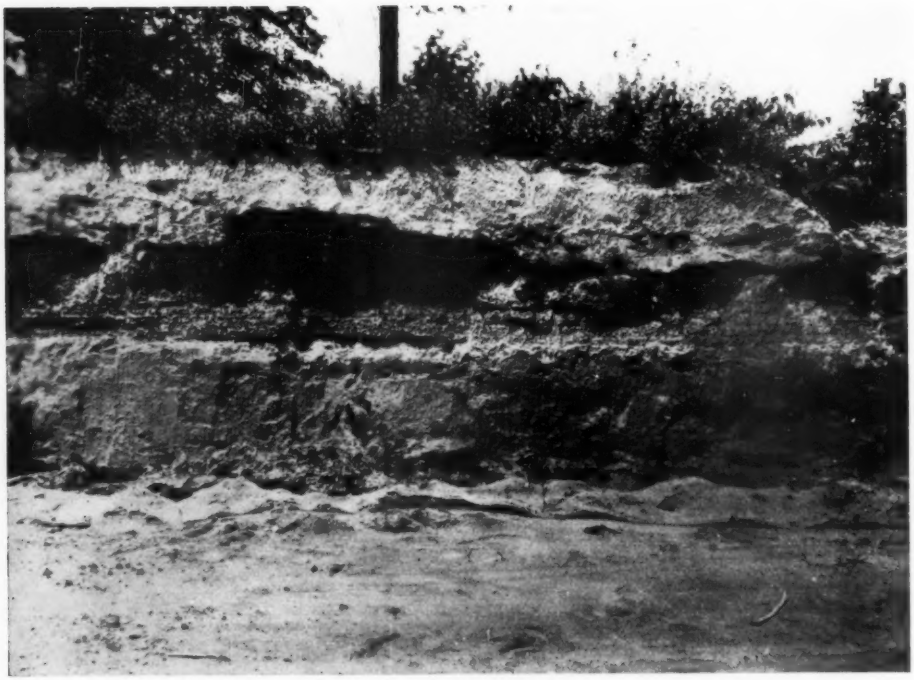


Fig. 9.—Post-glacial stratified sands, eight feet thick, overlying the varved glacial clay of Lake Hackensack. Mehrhof Brothers' clay pit, one mile south of Little Ferry, New Jersey

Fig. 10.—Post-glacial sand and gravel (a tributary delta deposit) overlying varved glacial clay of Lake Hudson, Hornbecker's sand-pit, West Haverstraw, New York

St. Nicholas Avenue, stratified sands were exposed in January, 1926, the uppermost stratified layer being 26 feet above mean sea level. Special interest is attached to this locality because the skeleton of a horse *Equus caballus* was found by the writer, embedded in the bank (Figs. 11 and 12). The skeleton lay on top of the highest stratified bed and in some six feet of unstratified yellowish gray clay which may have been washed down in post-Columbian time from the hillside below the site of the College of the City of New York.

In the excavation for the New York Telephone building at Barclay, Vesey, and Washington streets, New York, bed-rock (Manhattan schist) was encountered seventy-five feet below high tide on the Hudson River side and sixty-five feet on the eastern side. Between the bed-rock and the surface, stratified gray and red sands were noticed with occasional pockets of pebbles and a few ice-transported bowlders. At a depth of 45 feet below high tide, a bed of peat eighteen inches in thickness was observed by the writer, interbedded in the coarse sand, and associated with it the prostrate trunks of several juniper trees, *Juniperus communis*, some ten

Fig. 11.—Skull of horse, *Equus caballus*, found at base of the post-glacial clay. Subway excavation 134th Street and St. Nicholas Avenue, New York City

Fig. 12.—Stratified post-glacial sands west bank of Subway excavation 134th Street and St. Nicholas Avenue, New York City. Skeleton of horse, *Equus caballus*, probably 300 years old, found at elevation marked X

feet in length. The bark and a number of the branches still adhered, indicating that the trees and peat had grown *in situ*. Dr. Arthur Hollick[1] of the New York Botanical Garden examined a cross-section of the trunk of one of the trees and counted some two hundred rings representing as many years for its growth. These objects indicate that during their period of development the sands containing them were at sea level. The present position indicates later subsidence of the region.

The stratified beds of sand and gravel which rest upon the varved clay deposits are, without doubt, of post-glacial age. Since this is true where the clay is exposed, it is also evidently true where the clay beds are concealed from view by sands and silts, as in the Hudson River opposite 10th, 14th and 33d streets, New York, and in the East River channel. The stratified sandy deposits which occur at higher levels in Manhattan and Brooklyn are also considered to be of post-glacial age.

CONCLUSION

In conclusion it may be stated that, following the retreat of the ice of the last glaciation, glacial lakes occupied the basins between the terminal moraine and the various annual positions of the ice-front. The more notable of these lakes in the vicinity of New York City were glacial lakes Passaic, Hackensack, Hudson, and Flushing. As the ice retreated from year to year, varved glacial clays were laid down on the bottoms of these lakes. The presence of more than 2500 varves in the Hackensack valley indicates that the rate of retreat was slow, probably 100 feet per year. As the load of ice was gradually removed, the region was differentially uplifted approximately two and a quarter feet per mile from central New Jersey northward into east central Canada. This post-glacial uplift rejuvenated the streams and caused them to transport and deposit gravel, sand, and silt over the seasonally stratified beds of clay. Following the differential uplift of the land, the presence of a peat bed and tree trunks in the post-glacial sands forty-five feet below high tide in lower New York City, indicates that the region about the mouth of the Hudson River has gradually subsided. These various geologic events immediately precede the present day; how far back they go in time we can but estimate, yet the exploration and the counting of the clay varves which are in progress are affording a precise record of the annual retreat stages of the ice and the duration of the glacial lakes.

The present investigation has yielded not only an interesting series of Museum specimens, but also a new chapter in the palæogeography of the region. Further study will reveal additional data, a more accurate geochronology and a better understanding of glacial and post-glacial events.

[1]Hollick, Arthur, 1926, "Report on a Tree Trunk and Associated Lignitic Débris Excavated in Manhattan Island," *American Museum Novitates*, No. 213, pp. 1-6.

Fig. 1.—Nest of the butterfish, *Pholis gunnellus*. Here the egg mass guarded by the female fish is shown in the reversed upper valve of a dead oyster shell. A number of live limpets were attached to the inner surfaces of both valves. Photograph from exhibit in American Museum

The Nest and the Nesting Habits of the Butterfish or Gunnel, *Pholis gunnellus*

By E. W. GUDGER

Bibliographer and Associate, Dept. of Ichthyology, American Museum

ONE frequently reads in the daily papers brief notices of small fishes found in dead oyster shells, and only a few weeks ago a clipping of such a notice was sent to me by a correspondent. The matter never became very real, however, until December 16, 1924, when Nagele Bros. Inc., of 1066 Madison Avenue, New York City, sent to the department of ichthyology a dead oyster shell containing a little fish partly coiled around a ball-shaped mass of eggs. This shell with its contents had been dredged in Peconic Bay, at the eastern extremity of Long Island, on December 14. The fish and the eggs were dead, but the weather being cold, both were in perfect condition. The specimen, at once recognized as a gunnel nest, was taken to the department of preparation, where a sketch in colors was made of the shell with its attached limpets, of the fish, and of the egg mass. The fish and the eggs were then preserved in formalin.

It is a pleasure here to express our hearty appreciation of the courtesy of Nagele Bros. in sending this unique specimen, and all the more, since this is by no means the first interesting fish which they have contributed to the department.

PREPARATION OF THE GROUP

As soon as the little fish and the egg mass had become hardened by the formalin, a model of the fish was made and another of the eggs, exact in size and coloration; the shell was cleaned of mud, the limpets extracted from their shells and these latter reattached to the oyster shell in their exact positions. Then the fish and the egg mass were replaced in the "nest" just as they were when they came to us, and some artificial water was poured into the shell. Thus we have an exact replica of the gunnel in its "nest." Figure 1 shows the fish and nest as it will appear on exhibition in our new fish hall.

DESCRIPTION

The oyster shell (110 mm. long), as found on the bottom of Peconic Bay, was upside down, and the little fish and its egg ball were in the hollow of what is normally the upper or concave valve of the shell. The egg mass lay slightly forward of the middle of the valve longitudinally, and considerably nearer the back edge of the shell (that side next the observer) than the front. It was in about the deepest hollow of the shell. In order to estimate the eggs accurately, I found it necessary to tear the ball to pieces. Careful count then showed that there were 686 ova, a truly surprising number for such an apparently small mass. Unfortunately no measurements were made of these eggs before placing them in formalin, but, after they had been in this preservative for about seven weeks, repeated measurements showed that they were slightly (a mere fraction) over 2 mm. in diameter. Each egg contained an embryo in the black-eyed stage, coiled around the yolk. There are no filaments of attachment on the shells, but evidently when the eggs are extruded, the shells are glutinous and stick fast to all the other egg shells with which they come in contact. The eggs are certainly rounded up into a ball by the fish; how this is done will be described later.

Dissection showed that the guardian fish is a female. In European waters both sexes of this species are reputed to guard the nest, and the same thing is presumably true here. The warden of the nest shown in Figure 1 is 117 mm. (4.63 inches) in total length, and 13 mm. (0.5 inch) in greatest depth. Mounted as found, she lies in the shell with her head in the region of the hinge and her tail at the broad extremity. The first section of the body of the fish (about 47 mm. long) is comparatively straight, then the tail bends abruptly outward and forward, and in this sharp bend the egg mass is partly enclosed. This bent portion of the body measures about 30 mm. The remainder of the tail (about 35 mm. long) extends backward in a line roughly parallel with the anterior part of the body, the caudal fin lying on the shell in a somewhat horizontal position.

HISTORICAL ACCOUNT

Nilsson is quoted by various authors as saying that the gunnel spawns in November, but as no writer gives a specific reference to him, it has been impossible to verify this. However, it is undoubtedly true of our waters, since the eggs of our specimen on December 14 had embryos in the black-eyed stage, from which one would judge that they were at least two weeks old. Couch alleges that Peach found the ova of the butterfish in June attached to the under side of a stone in the harbor of Fowey, near Plymouth, in Cornwall, England. Since, however, there is no statement that the eggs were rolled into

a ball, and since the only proof that he had was the presence nearby of a supposed parent, and furthermore, since all other observers have found the egg-laying season confined to the winter months, one is forced to conclude that Peach was in error—his ova must have belonged to some other fish.

The first definite notice of the ova of *Pholis* is from the pen of Wm. Anderson Smith (1886). In March, 1883, between tidemarks on the shores of Loch Creran in western Scotland, he found "lumps" of ova and with each a pair (male and female) of suckerfishes, *Lepadogaster decandolli*. At first he thought that these were the eggs of the suckers, but as he knew that the eggs of those fishes were pinkish in hue and were more or less evenly spread over the stones, and since these eggs were in ball-like masses and "pale and opalescent" in color, he recognized them as the ova of *Centronotus* (the old name for *Pholis*); hence he decided that the lepadogasters had merely sought refuge under the stones where *Pholis* had deposited her eggs.

In a later article (1887) Smith fixes the breeding season as extending from about the middle of February to about the same time in April, March being the month of principal activity. The balls of opalescent ova (about the size of a walnut) entirely unattached but attended by both parents, may then be found under loose stones on the seashore at low tide. He thinks that the parents get no food save as the tide brings it to them, and that they undergo at least partial starvation. This I have found true of the male of the toad fish, *Opsanus tau*, which lays its adhesive eggs inside a *Pinna* shell or some other such hollow receptacle, and guards them. It is also true of the marine catfish, *Felichthys felis*, the male of which incubates the eggs in his mouth and does not feed at all during the period of gestation (about 80 days).

Smith further adds a thing which has not been reported by any other observer, that in captivity both parents lie coiled around the ova with heads and tails reversed, and that as the development of the ova proceeds the circle expands. When the young are hatched and free swimming, the parents (in captivity, at least) pay no further attention to the young but seek to get away from the light.

More definite is the information given by McIntosh and Prince (1890), who say of the ova of *Centronotus gunnellus* that:

> At St. Andrews they have hitherto been obtained amongst the rocks in March, masses about the size of a walnut . . . occurring in the holes of *Pholas* [the boring mollusk], the adults in each case being coiled beside them. The ova adhere together like those of *Cottus* or *Clupea harengus*, and have a diameter of 0.076 inch [1.9 mm.]. . . .

Further on in this paper they say of the same fish that:

> Masses of ova about the size of a Brazil-nut [English walnut rather] have more than once been found in cavities (holes of *Pholas*) at the Pier Rocks [St. Andrews], with the parent fishes coiled beside them. The examples specially dealt with occurred on March 14, 1887.

Here, then, we have evidence of a long breeding season such as would be expected in the cold waters of Scotland.

Still more definite is the report of Holt (1893) whose work was also done at St. Andrews. Beginning in November, he made constant search at low tide among the rocks but found no nests. However, he did collect a number of the fish, which were placed in aquariums and kept under observation. Early in February a female was noticed with enlarged abdomen, and a

fruitless attempt was made to "strip" her. Shortly thereafter unfertilized eggs were found in the aquarium and artificial fertilization was attempted but failed. On February 10, when attention was again called to the aquarium, one of the fish had spawned, the eggs had been fertilized, and the female was engaged in rounding up the mass of eggs into a ball. Of this process

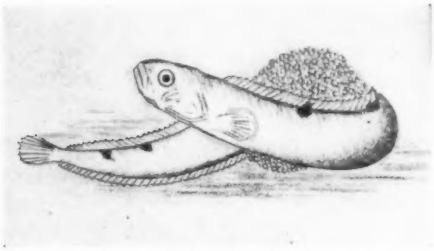


Fig. 2.—The first figure ever published showing the egg mass surrounded by the body of the parent butterfish (either male or female). After Holt (1893)

Holt gives a beautiful figure which is reproduced herein as Figure 2. The process he describes as follows:

> The body was bent so that the head rested on the back of the caudal region, the ball of ova being held in the loop so formed. In this position she sometimes rested for a short time, at intervals constricting her body so tightly that the egg mass slid over her back, only to be again encircled. I did not on this occasion observe that any assistance was given by the male. Several males were present in the same vessel, and I do not know which one fertilized the eggs.

Holt was fortunate in having another female spawn on February 22. He notes that the eggs were treated in the same way and adds that:

> This time, however, the male parent, much smaller than the female, took turns with the latter in compressing the eggs. The two parents did not seem ever to interfere with the eggs at the same time, but if one left them, the other very soon approached and encircled them. From the fact that the first clutch of ova, which were not fertilized, were also not rolled together by the parent, I suppose that the male is largely responsible, or takes the initiative, in this process, probably also fertilizing them at the same time. The object is evidently to prevent the ova, which are adhesive only when first extended [*sic*—extruded?], from being scattered and lost, and it may be supposed that the operation is performed before the eggs are deposited in the narrow crevices in which they have been found.

Holt comments upon the unusual fact that both parents take part in the formation of the egg ball and in the later care of the "nest." His conjecture that the male constricts the egg mass at the same time that he fertilizes the eggs seems sound, since this would certainly bring about a thorough admixture of eggs and sperms, insuring a high percentage of fertilization. However, his suggestion that the egg-ball is made and then placed in the constricted places where usually found, seems hardly probable to me. The question at once arises as to how the ball could be carried, lifted, and guided into crevices and into holes bored by *Pholas*. Furthermore, in our specimen, the two shells of the oyster were in place and closed when brought to us. If they had not been closed, fish and egg mass would have been lost when the oysterman's dredge was hauled or in the course of transportation the ninety miles to the city. And if the shell were closed, how could the fish have opened and held it open while the egg mass was being carried into it? The shell was lying with the upper valve below, and with the lower and lighter valve above. The two valves do not fit accurately, and it seems entirely possible for this active little blenny to have insinuated its snout between the edges of the valves and to have raised the lighter upper (really ventral) valve enough to have permitted the entrance of its slender eel-like body. Thus everything goes to prove that in our specimen

Fig. 3.—Photograph of the gunnels and their nest in a dead oyster shell from Helgoland. As in the American Museum specimen, the eggs and guarding parent are in the hollow of the overturned upper valve. After Ehrenbaum, 1904

at least the eggs were extruded and the ball formed within the shell, the "nest."

The eggs of Holt's specimen when still young (i.e. immediately after the formation of the perivitelline space) measured 1.75 mm. in diameter, while the clear, translucent colorless yolk had a diameter of 1.37 mm. These accurate measurements were evidently made with a micrometer eyepiece or slide, and are of no small value. Of equal interest and of more value to us, is his beautiful figure of the fish encircling the eggs as seen in No. 2 herein. His figures and descriptions of the development stages need not detain us, since they are apart from the purpose of this paper.

Our next, practically our last, and certainly our most illuminating data comes from Ehrenbaum (1904) who studied the fish at Helgoland. Ehrenbaum's photograph is reproduced herein as Figure 3 and his account is quoted as follows:

> The nut-sized egg balls are deposited from November to January in rather shallow water, mostly within empty oyster shells, or in holes bored by *Pholas*, and are there guarded by the parent fish. The eggs are whitish opaque, iridescent, on the surface, and in Helgoland are 1.9–2.2 mm. in diameter, with a 1.7 mm. yolk mass, which leaves quite a large perivitelline space. In the yolk, surrounded by a detritus-like mass, lies the oil globule 0.53-0.63 mm. in diameter. From January to the end of March, the larvæ hatch out with a length of about 9 mm. . . . By May or June the young have attained a length of from 25–30 mm.

The "knifefish" (so called because its body is shaped somewhat like the blade of a knife) is very abundant at Helgoland, and Ehrenbaum set himself the task of working out its breeding habits. Of his observations he writes:

> It is easy at all times of the year, with the exception of the winter months, to collect the fish in the shallow waters on the west side of the island and on the reefs—where one finds it in the holes bored by *Pholas* in the chalk cliffs, holes like those at St. Andrews. But there was never any success in finding egg clumps of this fish in these localities and particularly in shallow water. They were always found only in water about 24m. deep and moreover in one locality only—the Helgoland oyster banks, which lie about 4 miles southeast of the reefs. In 10 years only six times have I found the walnut-sized egg clump which proved to be that of *Pholis*

gunnellus and I was not at any time successful in getting the parent fish with it. At first the egg balls were only seen lying loose among the haul of the oyster dredge, but later it appeared that more normally they were in the empty oyster shells and were caught with these.

When the same kind of shells with their egg balls were put in the aquarium where there were "ripe" *Pholis*, one or even more fishes would regularly place themselves within the empty shells as shown in the photograph from life (Pl. XIII). It is possible, as Holt has observed, that the fish were guided by some instinct that impelled them to guard the eggs. I could not make out whether the male or the female played the more important role in this guarding. One could only have been sure of this if the ripe fish had deposited their own eggs in the empty oyster shells. Even then one could not be certain since apparently the fish could not shed their spawn, and regularly died after a certain time.

However, that the fish do regularly deposit their eggs within empty oyster shells and then stay in the shells to guard them, I was assured by Oberfischmeister Decker, who has often observed this occurrence on the Sylter oyster banks and has often caught fish and egg ball together in the empty oyster shells. The Sylter banks are neither so distant nor so deep as the Helgoland ones, and it may be explained that it is easier to take the fishes in the oyster dredge there, whereas, when the dredge has to be drawn through a greater distance, they escape into the water more easily through the meshes of the net. According to Decker's statement the butterfish and its eggs are also a common occurrence on the oyster banks in the shallow waters of north Friesland.

Ehrenbaum kept numbers of these fish in aquariums in his laboratory, hoping to see the method of spawning and the making of the egg ball. For a long time he was unsuccessful, but on January 28, 1904, after the above was in type, a mass of eggs was laid, fertilized, and underwent normal development. These eggs varied in diameter from 1.98–2.11 mm. with an average of 2.06 mm. Ehrenbaum noted with surprise that the parent fishes were very careless in guarding these ova, but this is possibly explicable on the ground that they were free in the aquarium and not sequestered in a "nest"—they were in an abnormal habitat and the behavior of the fish was for that reason abnormal.

It is interesting to point out that in Ehrenbaum's photograph both parents, the egg ball, and the oyster shell are shown almost in natural size. One of the parents rests on the bottom just outside the shell, with its body bent in semi-coils almost exactly like the body of our fish. The other fish with the egg mass in front of it is found within the empty oyster shell as in our specimen, but with the head at the gaping mouth of the shell and the tail in the region of the hinge. But most significant of all is the fact that fish and egg mass are in what is morphologically the upper valve of the shell and are covered by the lighter ventral valve—exactly as in our specimen here in the Museum. The reasoning given for this state of things for our specimen is, of course, entirely applicable here.

Ehrenbaum further notes that the egg laying takes place late in the calendar year; that butterfishes taken then have the sexual organs "ripe," and that their coloring is very vivid, particularly so in the males. Then he specifically records the following facts:

> The egg balls that I saw were all taken in December and January,—the earliest on December 23. In these particular eggs, however, the embryos were quite far developed, about 10 days before hatching, so that the eggs must have been laid in November. The date of the latest collection was on January 17. The size of these eggs ran from 1.92–2.17 mm., and the average diameter varied [presumably for each lot] from 1.99–2.12 mm. Each egg contained a large oil drop, clear as water, with a diameter of from 0.53–0.63 mm. All these measurements somewhat exceed those given for British specimens.

Two other citations may be noted—both from J. T. Cunningham. In a book published in 1896, he briefly refers to the nesting habits of the gunnel and reproduces Holt's figure already given herein as Figure 2. Again in 1912, in a work in which, as joint author, he wrote the section on fishes, Cunningham synopsizes the data with regard to the breeding habits of *Pholis gunnellus*, and on plate XXVII he gives a figure which, as may be seen in No. 4, is very interesting and attractive. In his text he refers to Holt's observations and then (separately) refers the reader to this figure. Next he speaks of Ehrenbaum's studies of the oyster shell "nests." There are three figures on Cunningham's plate XXVII, of which the first and second are copied from Ehrenbaum. The third figure (that of the butterfish and egg ball) is probably made up from Ehrenbaum's photograph.

In conclusion, attention may well be called to the fact that the American Museum group is the only known gunnel "nest" on exhibition in any museum; and that in it the only reproduced parts are the perishable fish and ball of eggs. Furthermore this is but one of a number of small "groups" which

Fig. 4.—The butterfish coiled around its egg mass
After Cunningham, 1912

we plan to install in the new Hall of Fishes in the Museum, each to portray the most interesting phenomenon in the life history of some particular fish —and, if possible, to show some episode in its domestic life.

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DICYNODON PLATYCEPS **BROOM, FROM NEW BETHESDA, CAPE COLONY**
One-fifth natural size

The skull was found about ten yards away from the greater part of the skeleton and may not belong to the same individual, but it is undoubtedly the skull of the same species and of an animal of similar size. The fragments of the fore limbs were also found some yards away, and may not belong to the same individual, but they, too, are of the same species. All the rest of the skeleton was found associated

Fossil Hunting in the South African Karroo

By R. BROOM, F. R. S.

Corresponding Member of the American Museum of Natural History

SOME time during 1912, I resolved for various reasons to dispose of my collection of fossil reptiles to the American Museum. I had come out to South Africa in 1897 to work up the wonderful reptiles of the Karroo, and to try, if possible, to solve the problem of the origin of mammals; but it was not until 1900, when I settled at Pearston, that I was able to do any collecting or even to handle more than half a dozen specimens. Pearston is not rich, but I found enough specimens to keep me well occupied, and I began to send off numerous papers to London dealing with the fossil forms.

One or two English scientists in those early days seemed to appreciate the work I was doing, but it was from America and Germany that the principal encouragement came. The great importance of the Karroo fossils in the geological history of the world had been recognized years before. Owen, more than eighty years ago, first revealed the wonderful half-mammal half-reptile types. In 1888 Seeley visited South Africa under the auspices of the Royal Society and, with the assistance of Mr. T. Bain, collected many new, interesting forms and greatly added to our knowledge. His discovery of many new, strikingly mammal-like reptiles showed that the Karroo reptiles were much more important than had been realized, and the scientific world became intensely desirous of still more knowledge of them. Just before the Boer War, the American Museum was planning a fossil hunting expedition to the Karroo, but by the time the war was over, in 1902, I was in the field and had already done considerable work. Professor Osborn, who for some years had been deeply interested in the problem of the origin of mammals, wrote me kind letters of encouragement and of appreciation of the work I was doing. For a number of years I was attached to the Capetown Museum, and was unable to repay my debt of gratitude to America, but, after going to the Transvaal, in 1910, I hoped to get together a collection that would find a resting place in the American Museum, and one of which America would be proud.

I had a good representative collection from our lower fossil beds, and I got a fairly good one from the higher beds, but little was known of the fossils of the intermediate period, and there was no good collection in any museum. I learned that fossils had been seen at New Bethesda, a little village about forty miles north of Graaff Reinet, and, as this was almost certainly on the horizon I wished to study, I made a journey to it at the end of 1912. The village is situated in a deep valley on one of the upper tributaries of the Sanday's River. The surrounding hills are composed of shales and sandstones, with here and there layers of igneous rock. Though not entirely barren, the shales of these hills I soon found were very poor in fossils. But in the village, the river, which for the greater part of the year is dry, has a flat bed of shale about 200 yards wide, and this I found to be exceptionally

doubtedly the skull of the same species and of an animal of similar size and may not belong to the same individual, but they, too, are of the same species. All the rest of the skeleton was found associated

rich. I don't know how long it would take an expert museum collector to collect from an area 50 to 200 yards wide and three-fourths of a mile long, but it took me the best part of a month working hard every day. The

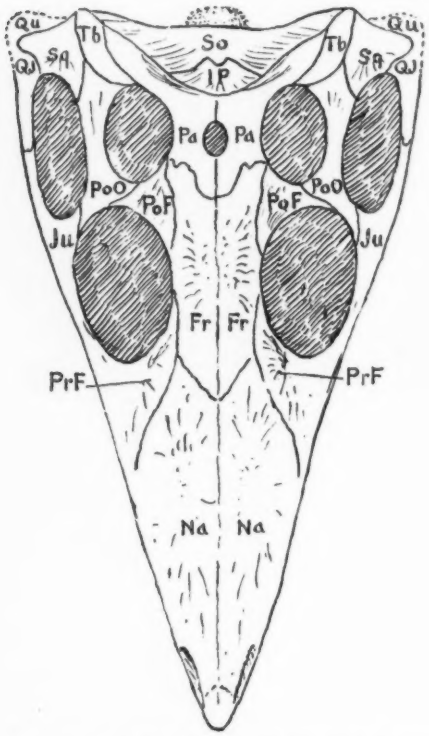

Fig. 2.—Skull of *Youngina capensis* Broom. About one and one-half times natural size

most striking specimens were skulls of a fairly large new species of *Dicynodon* which I named *Dicynodon platyceps*. It is a mammal-like reptile about the size of a half-grown pig, and of a somewhat similar robust build. The dicynodons are represented in the Karroo by many species—some as small as a rat and others nearly as large as a tapir. They had horny beaks like the tortoise, but with, in addition, usually a tusk in the male. Specimens were found of young animals of all ages, some as small as kittens.

One or two interesting skulls were found of the carnivorous types belonging to the Gorgonopsia,—a suborder of reptiles very near to the mammalian ancestor. Some remains were also obtained of a small Pareiasaurian,—a little form about five feet in length, with a broad head and the back covered with bony plates. But by far the most interesting discovery I made was the skull of a small new type of reptile, which I named *Youngina*.

Youngina is a lizard-like animal with a pointed skull of a primitive and most interesting type. The crocodiles, the dinosaurs, and many early reptiles have in the back region of the skull two large temporal openings. The lizards have only an upper one, but it looks as if there has been a lower one lost by the non-development of the lower bar; hitherto, we have had very few specimens which throw light on the early development of the lizard skull, and this skull of *Youngina* is the oldest known in good condition with two temporal openings. Two other specimens of *Youngina* have since been found, and the writer holds that it is the representative of a new order of reptiles which he calls the "Eosuchia." This order he believes contained the ancestors of the crocodiles, the dinosaurs, the birds, and the lizards. If he is correct in this, the great importance of *Youngina* in the evolution of the reptiles will be manifest.

I spent a few days on the farm Wilgebosch about four miles from New Bethesda and on a higher horizon. Here I found a number of new and interesting specimens, including the fine carnivorous skull which I named *Scymnognathus angusticeps*. Mr. I. H. Martins was also a guest at this farm at the same time, and, taking a keen interest in fossil hunting, he gave me

much help. It was he who discovered the beautiful little skull which I named after him, *Ictidoshinas martinsi*.

As Wilgebosch is only about five miles from Compass Berg, the highest mountain in Cape Colony, Mr. Martins suggested that we climb it, as I might not again have so favorable a chance. We agreed to go the following morning. At 6 o'clock the mountain peak was covered with mist, but at 8 it began to clear. We got a pair of horses and started. The usual ascent is by the northwest side, where the climbing is not dangerous, but is very troublesome because of the broken nature of the ground, so we resolved to ascend by the east side. We rode as far up the base as possible and tied our horses to bushes, and ascended by a long, steep gully. The mountain, which is 8000 feet high, is formed by a huge sheet or mass of igneous rock so arranged and weathered that the north side has an irregular slope of about 45°, and the south side has an abrupt precipice of 2000 feet. The climbing was neither difficult nor dangerous till we reached the top of the crest overlooking the precipice, but here we seemed cut off from the very top, only 100 yards away, by a bridge about 30 yards long and 8 or 10 yards wide. Its top had a slope of 45° toward the 2000-foot precipice and there was only a ledge less than a foot wide on which to walk. After some hesitation and a ten-minute rest, we risked it. But at the end of the 30 yards we seemed balked again. We climbed up the few yards of slope to find a precipice of some hundred feet on the north side. With my help Mr. Martins climbed first over a projecting block which overhung the precipice, and then helped me up over the same block. Soon we were at the top, and had a glorious view for over 100 miles around. We descended by the same dangerous track as we had come, as it would have been difficult to get our horses otherwise. Near the bottom of the mountain I found another good *Dicynodon* skull. We were back at Wilgebosch in time for dinner. Coming down the mountain, I saw

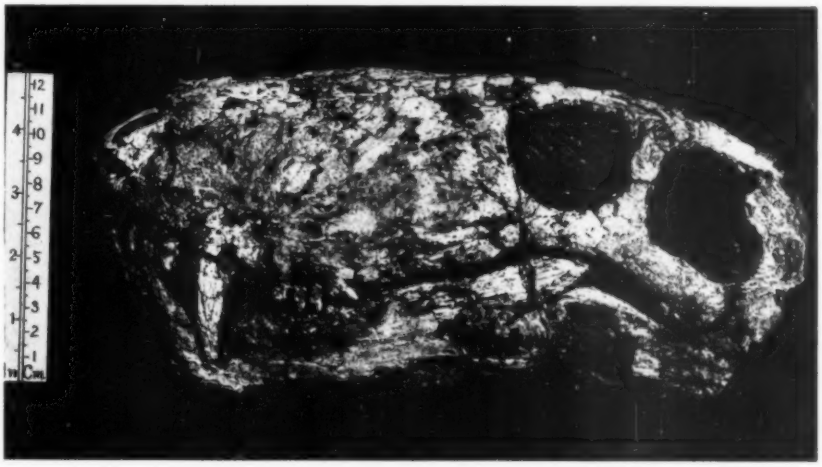

Fig. 3.—*Scymnognathus angusticeps* Broom. This is one of the South African reptiles from New Bethesda closely allied to the better known Russian *Inostrancevia alexandri*

burrows of the little garden mole, and was greatly interested, as I knew it must be a very rare species or a new one. I told Miss Jansen, the farmer's daughter, and asked her to try to get me one. When I returned to South Africa in 1916, I found she had a specimen in spirits awaiting me. It turned out to be the rare *Chrysochloris schalteri* which I had named some years before from near Beaufort West. Only six specimens have been seen, and this specimen is now in the British Museum.

I always think it is well for the fossil hunter or other naturalist not to confine his attention to one group only. When in the veldt after fossils, I always keep my eyes open for rare plants and have been able to add a considerable number of new species to the South African flora; and one of the most conspicuous aloes of the northern Karroo has been named after me, *Aloe broomi*. When one has gone fossil hunting and has drawn a blank, as often happens, it cheers one to discover a new or rare lizard or mammal or to find a new plant. Not long ago, when after fossils, I found a rare, succulent *Hoodia dregei* which was discovered in 1830 and has never been seen since. Even the ordinary tourist would find a new joy in life, if he took a keen interest in field botany or some branches of natural history.

A Journey in South America

By T. D. A. COCKERELL
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WE went to Siberia because Mr. A. Kuznetzov discovered fossil insects on the banks of the Kudia River. For similar reasons, it appeared necessary to visit Argentina when we learned that Mr. G. L. Harrington had found insects of Tertiary Age in the rocks at Sunchal, in the Province of Jujuy.[1] The matter was of peculiar interest, as until very recently no fossil insects of any kind were known from South America. The first to be found were two species from the Rhætic beds near Mendoza, in the foothills of the Andes. These were discovered by Dr. G. R. Wieland, of Yale University, in 1917, but not published until 1925. One of them, a very fine specimen, belongs to the Homoptera; the other is fragmentary and dubious.[2] In 1923 I described two small flies from amber found in Colombia, of uncertain age, but not earlier than Tertiary. Ameghino, as I learned from Doctor Spegazzini, had some impressions of Pleistocene insects from Argentina, but they were not described, and cannot now be found.

Mr. Harrington's discovery was made in the course of his investigations for the Standard Oil Company. Going up a narrow trail in the Santa Barbara district, examining the greenish beds so prominent in that region, he was surprised to find a layer or pocket of well-preserved fossil insects, nearly all beetle wing-covers. Not only were these the first South American Tertiary insects, with the dubious exception of the amber flies, but they were of considerable importance as a possible means of dating the deposit, hitherto supposed unfossiliferous. Most of the specimens were sent to Dr. R. S. Bassler at the U. S. National Museum, and were transmitted to me for study.[3]

Thus it came about that on June 13 we took passage from New York on the S. S. "Vestris" of the Lamport and Holt line. For reasons of economy we went second class, and had no occasion to regret the arrangement. Indeed, it was especially fortunate, as I found next to me at table the enthusiastic Swiss anatomist Dr. Ernst Huber, now of Johns Hopkins University. The officers of the ship, from the captain to the cabin steward, did everything possible to make the voyage pleasant and interesting. As we crossed the line Father Neptune and his beautiful daughter came on board, and after the initiation ceremonies we were all presented with certificates, promising aid and comfort from the powers of the sea whenever needed. Actually, I have not felt the slightest tendency to sea sickness since that time. Neptune, when not engaged in his regular duties, appears on earth disguised as a noted polo player, a fact in natural history perhaps now first recorded. As we passed through the region of sargasso weed,[4] we tried to secure

[1] Cockerell, "Tertiary Fossil Insects from Argentina," *Nature*, Nov. 14, 1925, p. 711.

[2] A figure published by F. Kurtz (Act. Acad. Nac. Cienc. Cordoba, VII) of a fossil from Cacheuta, in the same vicinity, appears to represent the end of the wing of an Orthopterous insect related to *Elcana*, of the European Lias. Dr. Wieland kindly furnished me with a photograph of this figure, with the comment that it was surely an insect, though named as a plant (*Baiera argentina*).

[3] Seven beetles and a caddis fly were described; *Proc. U. S. National Museum*, Vol. 68 (1925) Art. 1.

[4] *Sargassum*, a genus of large floating seaweeds with very numerous species.

Rhætic locality at Minas de Petroleo, Argentina. (Photograph by D. O. King.)

some by means of an improvised wire hook on the end of a string. Many trials were unsuccessful, but at last a persistent passenger secured a piece, and with the aid of a small microscope we were able to demonstrate the presence of various small animals. Later on, the captain interested himself in securing samples of the ocean bottom for us, which he brought up on the sounding lead. The surface waters, expected to be full of plankton, were barren so far as our few examinations showed.

We had a day and a half in Rio de Janeiro. I have elsewhere[1] described my visit to the Institute Oswaldo Cruz, one of the finest scientific establishments I have ever seen. However, it was not possible to do any natural history work of consequence at Rio, but I managed to collect a number of insects and snails in a vacant lot just across from the docks. Most conspicuous were the Orthoptera or grasshoppers.[2]

On the evening of July 3 we had a short time in Montevideo, where we saw armadillos and snails offered for sale as food. The snails were *Helix lactea*, or a closely related form, introduced from southern Europe, where it is much eaten.

It was dark on July 4 when we arrived in Buenos Aires, and we made our way to the hotel in a storm of rain. Although it was not freezing, we had rarely felt so cold, coming as we had out of the tropics, and not being suitably dressed for such weather. The hotel was not heated, and we thought we were in for a rather uncomfortable time. From this discomfort we were rescued by Mrs. Harrington, the wife of the discoverer of the fossils. Mr.

[1] *Nature*, Dec. 26, 1925.

[2] For determinations of species collected or observed I am greatly indebted to Messrs. Rehn (Orthoptera), Aldrich (Diptera), Wetmore (birds), Rohwer (Hymenoptera), Dyar (mosquito), Killip (flowering plants), Seaver (fungi), Arthur (fungus), Barber (beetles), Bartsch and Henderson (marine shells), Williams (moss), Maxon (fern), and Rose (cacti).

Harrington was exploring in Bolivia, but he had spoken of us, and we were invited to the home at Haedo, a suburb of Buenos Aires, whence I came in daily on the "subterraneo" to do what business was necessary in the city. This was our first experience of the extraordinarily kind treatment which we received everywhere we went in South America.

It was a great pleasure to meet several of the prominent scientific men of Argentina, whose names had been familiar to me for many years. Dr. E. L. Holmberg, the veteran student of bees, was extremely cordial, and allowed me to examine his collection freely. He is a most versatile man, who has worked in literature as well as science. He presented to Mrs. Cockerell an autographed copy of a book of poetry, in which he narrated the legends of the country. He expects to publish more on *Coelioxys*, his favorite genus of bees, and on the wasp-genus *Cerceris*. His published work on bees has been accurately done and clearly set forth, forming an important contribution to the knowledge of the Argentine fauna.

The Natural History Museum, directed by Dr. Doello-Jurado, is full of interesting things. Unfortunately, owing to crowding it is divided into two sections, some distance apart. It is expected that a new and suitable building will be provided later. Dr. Doello-Jurado is a specialist in mollusca, and has developed an excellent collection of the species of the country. He showed me a small white *Helix* (in the broad sense) from Mendoza, which he was about to publish as new. In the museum I also found the well-known entomologist Juan Brèthes, whose writings on Hymenoptera I had been using for many years. We took time to see the botanical and zoölogical gardens. In the latter we were pleased to see living rheas, the "ostrich" of the country. These were the Argentine race, and were labelled *Rhea americana rothschildi*, a name given by Brabourne and Chubb in 1911. It happens, however, that in 1878 Lynch Arribalzaga and Holmberg proposed a *Rhea albescens*, which was nothing more than albinistic specimens. Wetmore (1926) points out that this was certainly of the Argentine form, which accordingly becomes *Rhea americana albescens*. In our subsequent journeys we saw no wild rheas, but they must be rather abundant, to judge from the great numbers of feather dusters, made of rhea feathers, offered for sale. The other species, Darwin's rhea, is now placed in a separate genus *Pterocnemia*, and the little-known name *pennata* of d'Orbigny replaces the familiar *darwinii* of Gould, which was based on a proper description of the bird. When later I met Mr. D. O. King at Mendoza, he told me of seeing rheas high up in the Andes in that region. He supposed them to be like those of the plains, but Doctor Wetmore tells me that they are really different, the *Pterocnemia tarapacensis garleppi* of Chubb. The species *P. tarapacensis* is from Chile, and the original *garleppi* is from much farther north, in Bolivia.

Taking the train, we went to the city of La Plata to see the famous museum, and especially the eminent naturalists C. Spegazzini and C. Bruch. The former is a botanist who has described innumerable fungi, many cacti, etc., and also has a good knowledge of zoölogy.[1] The entomologist Bruch, specializing in Coleoptera and ants, has perhaps the most perfectly prepared and arranged collection I

[1]Since we left we have had to lament the death of Doctor Spegazzini.

ever saw. At the time he was very keen about a large genus of Tenebrionid beetles, and had borrowed specimens from the British Museum to complete his monograph. He had prepared excellent photographs of all the species. He also had some very remarkable beetles obtained in ants' nests. The problem is, at present, how to publish all this admirable work. The museum, with statues of sabre-toothed tigers at the entrance, has been described by others. It was surprising, even after all we had heard, to see the many skeletons of extinct Argentine mammals, especially ground-sloths.[1] We were interested to note in La Plata a broad avenue named after the palæontologist Ameghino, who described so many vertebrate fossils.

After about a week at Buenos Aires, we took the train for San Pedro de Jujuy, far to the north, near the Bolivian border, and almost on the tropic. We had been advised that for facilities we should have to depend on the Leach Brothers at San Pedro, so I had called on the manager of the Leach firm in Buenos Aires. Shortly before we left, he produced a telegram, and said he could congratulate us on being invited to the Estancia. How much reason he had for his congratulations, we came to appreciate later, for the open-hearted hospitality exceeded anything we could have imagined or hoped for.

The Leach firm has had a remarkable history. In the Province of Jujuy it was discovered long ago that sugar cane could be grown to advantage. In the effort to develop the industry, machinery was imported from England, and a young engineer, Roger Leach, came out in an advisory capacity. He remained at San Pedro, and after a time it appeared that for various reasons the enterprise was not succeeding very well. Leach was convinced that success was possible, and so he and his brothers (four eventually came out) raised a loan and bought the business. They did so well that the money was repaid, with interest, in five years. It is now about forty-five years since the arrival of Roger Leach, and there has been built up a great series of estates or farms in the Province of Jujuy, raising not only vast quantities of cane, but also fruit, and even operating an asphalt deposit, from which the town of Jujuy has been excellently paved.

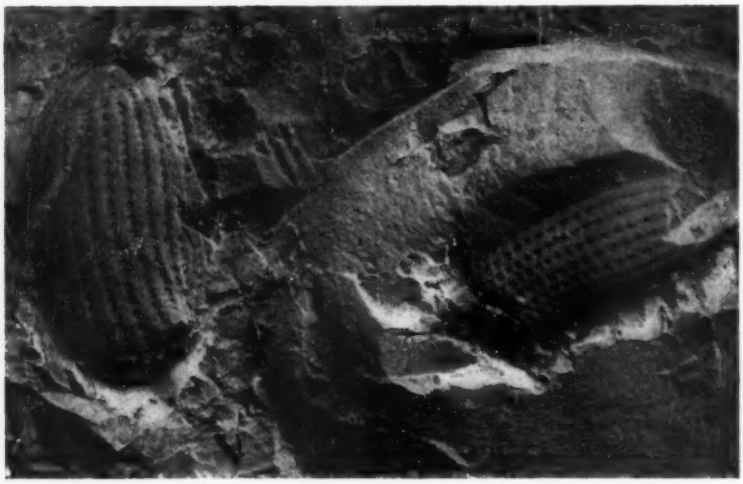
We were taken over the great sugar mill, and there I met Mr. Stephen Leach, and spoke of the wonderful work accomplished. He modestly disclaimed any particular merit, saying that he and his brothers had merely come to make money. Feeling that this was not the true explanation, I asked some who were in a position to know, and they told me that money appeared to mean little to the Leach brothers, who lived in the simplest manner, and devoted themselves to the welfare of the business and of the employees. What, then, is the underlying motive which has prompted and maintained such labors, extending over so many years? No doubt it is the same as that of the scientific man, the artist, or the statesman; the desire for self-expression and the accomplishment of worth-while things. I emphasize this point, because it illustrates the fact that public service, of one sort or another, is capable of satisfying human desires; and further, that an ostensibly private establishment like that of the Leach brothers operates as a public service,

[1]The extinct ground-sloths of Argentina are being elaborately described by Lucas Kraglievich of Buenos Aires. Recently I received from him two papers recording important discoveries.

especially if conducted as it has been. Just as we think of Harvard and Yale as great public institutions, though legally private corporations, so it comes about that big business has aspects in which it differs little from publicly owned enterprises. On the other hand, democracy cannot conduct its affairs without employing experts. If the Leach estates were turned over to the people of the vicinity tomorrow, their history would resemble that of many estates in Russia. Bernard Shaw humorously remarked that Scottish widows could lay an Atlantic cable, and did so, by getting people to do it for them. Thus, and thus only, may technical industries be maintained, and in any event the experts must be given powers as use-owners. The subject is a fascinating one, and I should like to write a book on the Leach estates; not at all in defence of capitalism, but as a study of the means whereby great functions may be developed in society, and of the underlying motives and interplay of human interests.

Going up in the train, we had the great advantage of being accompanied by Mr. Eugene Stebinger of the Standard Oil Company, who was on his way to Bolivia. Knowing the country, he helped us in many ways, and we were indebted to him for the loan of a small water-proof tent, without which we could hardly have maintained a camp at Sunchal. Passing over the great pampas, I was pleased to see the pampas grass, familiar on English lawns from childhood days, growing wild. We had to change trains at a small town called Perico, and strolling down the street, I found a large colony of earwigs (*Doru lineare* Esch.) under the bark of a Eucalyptus tree. The species was originally described from Brazil, but is very widely distributed, even entering southern Texas and Arizona. Arriving at San Pedro, we were met by Mr. Roy Gordon Anderson, under whose hospitable roof we were to stay. Mr. Anderson is specially concerned with the stock interests of the estates, including the development of polo ponies. He and his wife keep open house for visitors of many kinds, who seem to be constantly coming and going. It was the time of the sugar harvest, and every one was busy. Thousands of Indians were cutting the cane. I was interested to learn what I could about the insect enemies of the cane in that region. They have a moth-borer, and at times the migratory locusts do fearful damage. I could not find any mealy-bug; and various other pests common elsewhere appeared to be absent. The region is quite isolated from all other sugar-cane districts, which is a decided advantage. Though it was nearly the middle of the southern winter, the Anderson garden contained flowers and fruits. There were some of the common introduced scale insects. The fungus *Phragmidium disciflorum* was found upon the roses. I noticed a flourishing group of tall lantana bushes, and wondered whether there might be danger of their spreading and becoming a pest, as in the Hawaiian Islands. A search in the immediate vicinity revealed no seedlings. It was in the Anderson garden that I caught the only bee of the Argentine journey, a small species which I have described as new, *Halictus hiemalis*. In the warmer months there must be a rich bee-fauna, undoubtedly with many yet undescribed.

At the nearby settlement called Esperanza, where the sugar mill is situated, the estates maintain a hospital, and here I met Dr. Wm. C. Paterson, who is making a study of the



Fossil beetle elytra from Sunchal, much enlarged. The larger one is *Otiarhynchites aterrinus*. Photograph by R. S. Bassler

local mosquitoes. He showed me a fine species which he believed to be new. In the summer *Anopheles* abounds through all this region, and there is a good deal of malaria.

We now had to proceed to Sunchal, in the Santa Barbara mountains, a considerable distance east of San Pedro. Mr. Harrington had sent me a sketch map of the route. Mr. Anderson picked out for us a most excellent man, Daniel Rios, who took charge of the mules and helped us in camp. We were taken in an automobile as far as there was a road, well beyond the village of Santa Clara, and found Rios with his brother waiting for us. We had come through a dry region of cacti and scrub, with here and there a small palm. The large blue-green *Opuntia tuna-blanca* of Spegazzini was very conspicuous. Peccaries live in this open forest; we passed a man by the roadside with two which he had shot. Leaving the car, we took to the mules, and were soon in a very hilly country, going up and down steep trails, on which it was none too easy to keep our seats. After some hours of this, we were not sorry to stop for lunch. All afternoon we rode with increasing weariness, but in the evening reached our destination. Sunchal is not a town, but merely the name of a locality on the map, where there is a single, very poor ranch house. We pitched our tent in the orchard, under a tree. The ranchman was away, but the women treated us kindly, though they must have wondered what brought us there. Perhaps they were not altogether unfamiliar with wandering geologists, for the oil people go everywhere. It was striking to see the poverty and, as it seemed to us, wretched condition of the people, while their animals and poultry appeared most flourishing. The face of the older of the two women was horribly deformed from the Uta or Leishmania disease. Dr. Paterson thought it possible that the transmission of this disease might be due to buffalo gnats, species of *Simulium*. He had observed that where it developed there always seemed to be a running stream, suitable for the larvæ of

Simulium. There was just such a stream by the house at Sunchal, with water-cress growing in it.

We did not quite understand Mr. Harrington's directions, and it was more by good luck than intelligence that we found the deposit on the first morning. When we stopped for lunch on the way over, between Santa Clara and Morteras Pass, a little of the greenish rock was observed in the roadway, and in it we found an imperfect beetle elytron, resembling *Anthonomus sunchalensis*, but with the apex more pointed. The Harrington locality is some distance up the gulch from Sunchal, in a westerly direction. The trail branches at the bank of the little stream, and it is necessary to turn to the left, crossing the stream at this point. The exposure is on a hillside, right on the trail. Five minutes walk beyond, where a large tree has fallen over the trail, is another good exposure, rich in fossils. It was at this latter place that we found the little fish *Corydoras revelatus*, an armored catfish, the first member of the family Callichthyidæ to be found fossil. It is, of course, a fresh-water form. The rock represents solidified mud, which comes out in small blocks, with a conchoidal fracture. The insect remains are numerous, but fully 95 per cent beetle elytra. It is very rare to find two elytra together, and we get the impression that most of the specimens may come from the excrement of fishes. The fossils are preserved without compression. All the species so far discovered are small. Two of the elytra, belonging to the Cerambycidæ or long-horn beetles, are beautifully marked; one appears to belong to the existing Neotropical genus *Haruspex*. Aside from beetles, we obtained the forceps of an earwig (*Psalis*), part of the wing of a male cricket, a small plant-bug (apparently *Corizus*), and two species of Fulgoroid Homoptera, one referred to a new genus, the other to the existing genus *Ormenis*. There were also characteristic hind legs of a jumping Orthopterous insect. Undoubtedly much more material will be collected later on, now that the locality is known. I left exact particulars both at the museum at Buenos Aires, and with Doctor Spegazzini. The green rock extends over a large area, and I understand that remains of insects have been found farther south. It is interbedded at intervals with layers of heavy limestone at the Harrington locality. From the train I was able to see apparently the same kind of rock similarly interbedded, a short distance north of Perico. I also saw apparently the same deposit north of Tucuman, in many places weathering to make greenish soil.

This deposit appears to represent an ancient (Tertiary) lake, into which muddy rivers flowed. In its upper part it shows streaks of red, which increase until we come to an entirely red deposit, this gives the name to the Rio Colorado, which flows near Sunchal. We assume that we have clear evidence of increasing aridity, culminating in what were wind-blown desert sands, apparently wholly unfossiliferous. Above this is a thick yellowish deposit, still more recent. The insect-bearing shale, which we may term the Sunchal Formation, must be considered Upper Tertiary, very possibly not earlier than Miocene. As to the formations below it, I have no special opinion of my own. We followed up the gulch, and found older shales without distinct fossils. Still beyond, the rock is Devonian, and we were shown a very good trilobite picked up as "float" in

the same gulch. The folding and faulting in this region is excessive, so that it is very easy to make mistakes in geology. In a letter dated October 1925 Mr. Harrington says: "Have you any idea as to the age of these (insect-bearing) beds? That really is the 'question that agitates the public mind,' and I have been puzzling my head for the last five years over the age of the beds above the micaceous, fissile, black Devonian slates, and hope that the results of your studies here may throw some light on it. You know the limestone some distance below the beetle beds or variegated shales contains some turritelloid forms that I have forgotten the name of, but it appears that that particular genus may range down almost to the Triassic as well as up nearly to the top of the Cretaceous or thereabouts. Between that and the Devonian slates we have found no fossiliferous beds throughout the whole range of the territory from Jujuy to northern Bolivia east of the Andes."

The turritelloid shells, not found near Sunchal, were figured and named by the Argentine palæontologist Dr. Guido Bonarelli. He ascribed them to marine genera characteristic of the Triassic and Jurassic. From the figures I got the impression that they were fresh-water or non-marine forms such as we get in North America in the Cretaceous and especially the Eocene. Dr. T. W. Stanton, on being consulted, said he would not venture a definite opinion, but his impression was similar to mine. The general outcome would be, that this part of South America has been a land area for a very long time.

Bonarelli figured a "problematical fossil," which he did not venture to name, but which was suggestive of the Precambrian algæ types (such as *Collenia*) figured by Walcott in 1914. We found a characteristic block of this material, much too heavy to bring away, close to the fossil locality. It is supposed to be very much older, but I had the impression that it might have come out of the interbedding Tertiary limestone.

Although we were nearly on the tropic, the weather was cold, and there were few insects about. During a good part of the time we were in a Scotch mist, and all night the moisture condensed on the branches of the tree above our tent, producing a monotonous drip, drip, drip. The forests represent a dilute tropical biota, with magnificent trees, but no palms, nor were any monkeys seen. Great flocks of green parrots flew about, making a good deal of noise. At the ranch house they had one in captivity, and the notes I made on this enabled Doctor Wetmore to determine it as *Amazona aestiva*, originally described by Linnæus from southern Brazil. A fine looking jay, of large size, with a high pointed crest, and pale yellow under side, was *Cyanocorax chrysops*, probably (says Doctor Wetmore) of the subspecies *tucumanus*. I also saw what I took for a large rusty-red woodpecker, but it was really a passerine bird with the habits and appearance of a woodpecker, presumably *Xiphocolaptes major*. Doctor Wetmore, who corrected my erroneous impression, remarked that "the birds are wholly woodpecker-like in appearance and action," so they represent an astonishing case of "convergent evolution." I had often read of the Dendrocolaptidæ, and was particularly pleased to have seen one, and to have been appropriately deceived.

Close to the tent a large shrubby groundsel, *Senecio brasiliensis*, was in full flower. Its leaves were infested by

a rust-fungus. Two species of large columnar cacti (*Trichocereus*) were conspicuous in open ground. A *Solanum* (potato genus) with large broad lanceolate leaves, white flowers and red berries, was the leading herbaceous plant on the forest floor in the gulch. The ferns were many and varied. The nettle *Urtica darwinii* recalls the voyage of the "Beagle," though Darwin never visited this particular region. The common dandelion, of course introduced, was reminiscent of home. Two characteristic compositæ were *Onoseris hastata* (described from Bolivia) and *Tagetes tenuiflora* (described from Ecuador). In general, the plants and animals appeared to range principally northward, though often south as far as the vicinity of Tucuman. There was hardly any resemblance to the flora later observed in the vicinity of Mendoza.

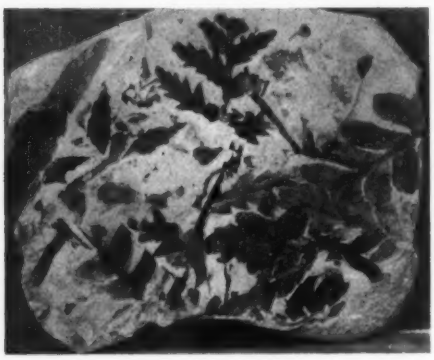
The greatest disadvantage came from the abundance of ticks and those larval mites often called chiggers. We not only suffered severely at the time, but could still feel some of the effects after getting back to Colorado.

When we came to make the return journey, we thought at first to take two days, and spend a night in the forest. But at the spot we had in mind there was no suitable forage for the mules, so we pushed on as far as the village of Santa Clara. Here night overtook us, and we were also thoroughly tired out. Asking permission to camp in the field in front of the best house we saw, we were recipients of the hospitality of Mr. and Mrs. Juan Tache, who did everything possible for us and would take nothing in return. The next morning an automobile came from Mr. Anderson's, and we were soon in San Pedro. Leaving San Pedro for the south, we took occasion to spend a night in Jujuy, the capital of the Province, and make the acquaintance of a local naturalist, Mr. Carlos Schuel, who has charge of the "Museo Provincial." The next day, having to change at Tucuman, we looked up the traffic manager for advice, and found a very cordial Irishman, from County Clare. We spent only a few days in Buenos Aires this time, but were fortunate in making the acquaintance of Messrs. Carlos A. Lizer and Everard E. Blanchard, specialists in scale insects and plant lice respectively.

On July 29 we left Buenos Aires, going directly westward across the plains to Mendoza, in the vicinity of which is Wieland's Rhætic locality, where he got two fossil insects. Arriving at Mendoza, we hastened to look up Mr. D. O. King, a member of the local railway administration, but also an extremely keen geologist, well acquainted with all the strata in the region. He is an Englishman, son of King of the Indian Geological Survey, and grandson of the geologist who is now especially remembered in connection with *Homo neanderthalensis*. Mr. King at once interested himself in our project, and through him we met Dr. Edwardo Carette, director of the public museum. Through the mediation of Doctor Carette, the Board of Education very kindly supplied an automobile with driver, to take us out to the Minas de Petroleo, the fossil insect locality. It was an all day trip, and the party included Doctor Carrette, Mr. and Mrs. King, Mr. Julio Mácola, and ourselves. The precise spot was found, and very soon we were getting out extremely fine fossil plants, and also finding plenty of the mollusc-like crustacean, *Estheria mangaliensis*. But with all our labors, we failed to find any remains of insects, and I very

recently heard from Mr. King, saying that he had searched since we left, without success. They appear to be extremely scarce, but undoubtedly more will eventually be found.

Messrs. Carrette and Mâcola are skilled botanists, and were able to give me the names of the various plants growing in the locality. As is well known, this desert flora has many features which recall that of Arizona and Northern Mexico. About forty species were identified, six of them being cacti. It was especially interesting to see two kinds of creosote bush, *Covillea divaricata* and *C. nitida*. Just



Rhætic plants from Minas de Petroleo, Argentina. (Photograph by Coulson.)

as in Arizona, the olive green bushes form a conspicuous feature of the landscape, extending up the valleys, and growing at intervals almost as if planted. In Arizona there is a very characteristic lac-insect (*Tachardiella larreae* Comstock) on the creosote bush, but at Mendoza the local lac (*Tachardiella lycii* Leonardi) is on *Lycium chilense*. We found the *Lycium*, but not the lac. The indications are that *Covillea* originated in the south, and spread northward in one species. The closely related genera inhabit the southern Andean region, and it is there that the genus shows some diversification, *C. nitida* being very distinct and peculiar. The same sort of thing appears to be true of *Prosopis*, or mesquite. We have in our southwest a few forms coming up from Mexico, representing two very different types often separated generically. At Mendoza we observed three species, *P. alpataco*, *P. striata* and *P. strombolifera*, the latter being a screw-bean, like our southwestern *P. pubescens*. One of the Andean forms is so like the North American *P. juliflora* that it has recently been proposed to regard them as identical. Doctor Rose writes that he doubts this conclusion, and considers that further critical study must be given to a number of closely related species in South America. He also thinks our *Covillea* distinct from all those to be seen in Argentina, though *C. divaricata* resembles ours very closely indeed. When we consider that on the west coast of South America desert conditions prevail almost to the equator, it is not so difficult to see how members of the Andean desert flora may have spread northward in earlier times. Whether the seeds may have been carried by migrating birds over part of the distance I do not know. There is a strong argument against actual continuity of desert at any time from Peru to Guatemala, not only in the nature of the country, but also in the failure of many types, especially of insects, to spread from the one region into the other. This whole problem of the northern and southern desert biota is of the greatest interest, and would well repay a lifetime of study.

The Mendoza country, in the first half of the nineteenth century, was the hunting ground of Gillies, who used to send plants to Hooker in England.

Aconcagua, 23,050 feet, the highest point in the Western Hemisphere, as we saw it when crossing the Andes from Mendoza, Argentina, to Valparaiso, Chile. (Photograph by D. O. King.)

Consequently, among the plants observed at Minas de Petroleo were *Trichocereus candicans* (Gill.), *Verbena scoparia* Gill. and Hook., *Berberis grevilleana* Gill. and Hook., and *Collinguaya integerrima* Gill. and Hook. However, Gillies did not succeed in recording all the plants; thus we observed the cactus *Malacocarpus catamarcensis*, the specific name of which was given by our friend Spegazzini.

On looking up the Mendoza plants in the Index Kewensis, I found that very many were said to come from Chile. This is misleading, and apparently due to the fact that when they were described Chile did not have its present boundaries, nor indeed were they distinctly settled. It used to be easier to get to Mendoza across the Andes than over the plains, and thus the whole country was, in a manner, tributary to Chile. The flora of the two sides of the Andes in this latitude is very different, as we were able to observe when we went across. It is a singular thing that in the more southern part of the Andes, as about Mendoza, it is the east side which is arid, while the west is much moister; whereas northward, in northern Chile and the whole length of Peru, the west coast is extremely arid, while the eastern slope is moist tropical.

Not to rely too much on impressions from the train, I took for comparison Jaffuel and Pirrion's list (1923) of the Flora of the Marga-Marga Valley, inland from Valparaiso. Of the forty species definitely noted at the Minas de Petroleo, the following are in the Marga-Marga list: *Lycium chilense*, *Proustia pungens* (but represented on the Mendoza side by a distinct variety *ilicifolia*), *Baccharis rosmarinifolia*, *Schinus dependens*, *Marrubium vulgare* and *Xanthium spinosum*. The last two, being common introduced weeds, are of little significance. In addition,

the following observed genera were represented by different species in the Marga-Marga list: *Berberis*, *Cassia*, *Gochnatia*, *Verbena*, *Lippia*, *Fabiana*, *Collinguaya* and *Tillandsia*. The rows of lombardy poplars, much planted on both sides of the Andes, were observed to be much infested with mistletoe on the Chilean side. Perhaps the most striking point of difference is in the Cactaceæ, which abound in species and individuals in the region of Mendoza, but in the Marga-Marga Valley are represented only by *Trichocereus chiloensis* (Colla), which is common, and an undetermined "*Echinocactus*."

The journey across the Andes, on the Transandean Railroad, is a wonderful experience. The beauty of the snow-capped mountains and the rich colors of the rocky slopes can hardly be described. We were fortunate in getting a good view of Aconcagua, 23,050 feet, the highest peak in the western hemisphere. Coming down on the other side, we found spring in Chile. We spent a night at Los Andes, in order to have a daylight ride across Chile to Valparaiso. In Valparaiso we found a most excellent hotel with extremely moderate charges, and had a short time to see something of the city. We climbed up on the heights back of the town, and finding a good many flowers, expected to see some of the native bees. In this we were disappointed, but we got some very beautiful flies. We sailed from Valparaiso August 5, on the "Santa Ana," and on August 7 had a chance to go ashore at Antofagasta. This was the most barren place I had ever seen. When I started out with my net, one of the passengers, who had been there before, laughed at me for expecting to catch anything. "You may," he said, "possibly get some fleas in town!"

I had never seen a desert where there was nothing to be had, so I walked boldly on to the rocky slopes back of the town, expecting to see some sort of desert flora. I could not find a blade of grass, or any green thing, except a small seedling *Mesembryanthemum*, with nine leaves. I caught two insects, a pallid Thysanuran and a small moth. Returning to the town, we examined the small park, full of flowers, and the few gardens. These are watered, I understand, from tanks brought down on the railway. About the gardens were some common weeds, *Malva rotundifolia* (mallow), *Erodium cicutarium* (alfilaria) and *Sonchus* (sow thistle). From under stones and dead leaves we got some interesting Tenebrionid beetles, and under dead birds on the shore carrion beetles, *Dermestes vulpinus* and a prettily colored *Saprinus*, the latter new to the U. S. National Museum. Certain flies found along the beach are reported by Doctor Aldrich to represent new genera of Ephydridæ and Sarcophagidæ. Before returning to the ship, we collected marine shells at the water's edge. The most interesting, found in considerable numbers, was the little *Rissoina helena* Bartsch, described in 1915 from two specimens with no better locality than "Peru." It was thus an addition to the Chilean fauna. The other shells were ordinary enough. An excellent summary of the marine shells of the Peruvian Province, including northern Chile, was given by Dall in *Proceedings U. S. National Museum*, 1909.

We did not go ashore at Arica, but stood for a time close to General Pershing's ship, near enough to be cheered by the sound of our national air, played by the band on board.

Coming to Ilo, at the southern end of Peru, we were halted in the evening in

order that disinfectants might be pumped into the hold, an apparently futile proceeding. Many moths and some other insects came to the ship's lights, and I made quite an interesting collection. It was essentially a sand-hill fauna, with *Deilephilia*, *Agrotis* (sens. lat.) and other things reminding one very much of the sand-hill Lepidoptera of Europe. On August 10 we reached Mollendo, and there left the ship to proceed by rail to Arequipa. Before leaving Mollendo, I examined a heap of stones in a very arid spot, and found a spider and a Thysanuran. The Thysanura are primitively wingless insects, often appearing fond of hot places. One species, for instance, occurs in bakeries. Did the first terrestrial insects have such habits, and if so, does that in part explain why we do not find them fossil, as we might expect to do, in Devonian strata?

The journey up to Arequipa was very interesting, and has been described in various books of travel. The train goes for some distance near the shore, enabling us to see a rather extensive sand hill flora. Then it turns inland, and crosses a perfect desert, which is here and there irrigated, and is then very fertile. At Ensenada cotton is grown and at Tambo sugar-cane was brought to the train. Presently we began to ascend the steep foothills, which are covered with verdure at an altitude of about 1,000 to 1,500 feet. This is the result of the fogs coming in from the sea. There is a great dearth of woody plants, but some cacti, and brightly colored flowers. The flora is by no means the same as that about Arequipa. Leaving this region, we came to another desert, with the famous crescentic dunes of blown sand. It was evening by the time we reached Arequipa, after a truly eventful journey. The extreme aridity of this coast is explained by the high mountains, which precipitate the moisture to the east, and the cold Humboldt current, which causes the rain from the Pacific to fall before reaching the coast. At rare intervals, this current is in some way deflected or changed, and warm water flows near the shore, resulting in torrential rains. This had happened a few months before we visited the country, and we could still see the effects at Arequipa and elsewhere. Such rains are destructive to buildings and vegetation, but were the current permanently altered in such fashion, the climate of the whole coast would be entirely changed. The character of the fauna and flora shows that such conditions as now obtain have remained essentially constant for a very long while.

We spent a night in Arequipa, and then started for Cuzco, which my wife was especially anxious to visit. The first day's journey is to Juliaca, 12,550 feet altitude, not far from Lake Titicaca. The ascent from the Arequipa Valley is rapid, and we pass through a region of desert vegetation, with many flowers, and eventually come out on the roof of the world, the home of the llama, where the vegetation is mainly bunch grass. But unfortunately, these matters suddenly ceased to interest me, for at an altitude of about 13,500 feet I succumbed to the dread malady "soroche," or mountain sickness. The symptoms have often been described, and I need only say that I was completely prostrated. Very rarely, a passenger dies under these circumstances; the majority experience more or less discomfort but many are immune. Fortunately, my wife was not affected, and other passengers in the car were as kind and helpful

as possible. I remember especially Mr. A. G. Maurique of Arequipa, who was indefatigable. We went over the highest pass, Crucero Alto, at 14,688 feet, and in the evening arrived at Juliaca, where I could do nothing but go to the hotel. After a very wretched night, I was carried to the morning train, and prostrate on soft llama rugs, returned in disgrace to Arequipa. It was of course a very great disappointment, in addition to the discomfort, for who knows what we might have seen and discovered in that high country? Even after reaching Arequipa (7,550 ft.) I had to spend a couple of days in bed. On the third I cautiously walked around the plaza, and witnessed a very interesting religious procession. After that I felt recovered, and was able to go about as usual. We were established at the Hotel Wagner, where we were very well taken care of, and had most comfortable quarters.

The Arequipa Valley is fertile under irrigation, much as the Salt River Valley in Arizona. The surrounding country is much like the Arizona desert, with scattered vegetation of many species. The city is a fine one, and to me was more attractive than Lima. Although the people in general are poor, and often wretchedly clothed, they seem cheerful, and are orderly. I saw no one drunken or behaving in an objectionable manner. Everywhere we were treated courteously. As one walks round the plaza, the magnificent cone of the volcanic Mt. Misti comes into view above the cathedral. This particular view is certainly one of the finest in the world; one is reminded at once of the pictures of Fujiyama in Japan. Misti is, however, 4,973 feet higher above sea level. We visited the Protestant Evangelical Mission at 414 Calle Mercadores, and were much interested in the good work being done. United States "culture" reaches the Arequipans in the form of movies, and one of the first things noticed was a huge announcement that Carlitos Chaplin was to be seen upon the screen. We denied ourselves this pleasure, but later, one evening, went to the movie at a venture, not knowing what was offered. What we saw was "The Ghost of Slumber Mountain," in which the dinosaurs come to life. We had seen the same film in Boulder several years before.

Naturalists are scarce in Arequipa, and the surrounding country is full of undiscovered things. Happening to go to the railway station to return the unused tickets from Juliaca to Cuzco, I found Miss Corry, who told me that her father, the chief engineer of the Southern Railways of Peru, was very much interested in botany. Unfortunately he was away at the time. Mr T. A. Corry was very helpful to Doctor Rose when he was investigating the cacti of the region, and we were much pleased to find at Tingo the fine species with lemon-yellow flowers, now called *Corryocactus brevistylus*. We were especially fortunate in making the acquaintance of Dr. Edmundo Escomel, a leading physician of the city, who is enthusiastically devoted to natural history, and has made many discoveries. His house is a veritable museum, and he has sent out specimens to specialists in various countries, so that his name often occurs in the literature. On the day we first met him, we had been to Tingo, and had captured the handsome black bee *Anthophora escomeli*, while we had been bitten unmercifully by the elegant little buffalo gnat *Simulium escomeli*. Several species of Hymenoptera, a neuropteron, a mosquito, a moss, and a large frog

found in Lake Titicaca, have all been named after Doctor Escomel. He has had little time for taxonomic work, being overwhelmed by patients, especially since in the goodness of his heart he treats the poor without charge. He has however specialized in the blister-beetle genus *Pseudomeloë*, which was used medicinally by the ancient people of the country.[1] He had recently revised the Peruvian species, six of which he had first described, while another, discovered by him, was named in his honor by Denier. Having seen these beetles in his collection, I was astonished to find at Tia Baya another species, not there represented, abundant on the little boraginaceous plant *Coldenia parviflora*. I had, in fact, discovered a new species of *Pseudomeloë* in Doctor Escomel's own district! He has since described it as *P. cockerelli*. Later, I found a single specimen of this new *Pseudomeloë*, on the same plant, at Yura.

We made many trips to Tingo, a suburb reached on the street car. It was by far the best collecting ground we found. We got twenty-three species of bees, of which ten were new to science, including a very remarkable new genus, with Australian affinities, captured by my wife.

From Tingo an omnibus runs to Tia Baya, where we spent a good part of one day. Only one new bee was obtained, but we got the new beetle already mentioned, and some other interesting things. A remarkable little cactus turned out to be *Arequipa leucotricha*, the generic name given by Britton and Rose in reference to the city near which it occurred. Another excursion was out into the desert toward Mt. Misti. It was excessively dry, but there were several flowers, including the handsome Bignoniaceous *Tecomaria arequipensis* (Sprague). A *Grindelia* or gum-weed looked very like our common Colorado species; Mr. Killip finds nothing like it in the U. S. National Herbarium, but suggests that it may be the *Grindelia peruviana* which is mentioned in the literature, but seems not to have been described. The curious fungus *Battarea digueti* Pat. reminded me of very similar forms I used to find in the deserts of New Mexico. I was much surprised to find a moss (*Anomobryum filiforme*) and a fern (*Notholaena arequipensis*) growing under excessively arid conditions. Williams had already recorded the same species of moss from a dry hillside at Santa Rosa, Peru. The fern was described a few years ago by Doctor Maxon.

Just before leaving Arequipa, we took the train and went up to Yura, 8,450 feet, a place famous for the hot medicinal baths. We got only one new bee not obtained elsewhere, but found the plants very interesting, many quite analogous to those of New Mexico and Arizona. The *Encelia canescens* showed two distinct forms, growing side by side. In one the foliage was greenish white, in the other light green, in great contrast. Doubtless they are Mendelian segregates, but the former would be expected to be adapted to more arid conditions. Near the warm stream was a great quantity of *Mesembryanthemum*, and we found *Mimulus* in flower. There were two handsome species of the potato genus, *Solanum phyllanthum* and *S. radicans*. A dodder (*Cuscuta*) looked like those of the United States. *Senecio teretifolius* was a groundsel allied to a species of our southwest. Although both the Mendoza and Yura floras reminded us

[1] Called Ychuccaspa in the Quichua language; see *Bull. Soc. Path. Exotique*, XVI, (1923), p. 621.

in many respects of the deserts of North America, they did not remind us of one another. Yura is very much poorer in woody species than the Mendoza district. A species of mistletoe referred to *Phrygilanthus cuneifolius* was found in both regions, though the plants seemed to me to be appreciably different. At all events, the seeds of this genus are readily carried by birds, so we should expect a wide distribution.

On August 24 we were back at Mollendo, and took passage on the "Santa Elisa" for New York. The next day we had a short time at Pisco. As we walked down the long pier, we heard what seemed to be the grunting of innumerable pigs beneath us. Looking to find what kind of sea-pigs there might be, we observed that the noise came from black cormorants (*Phalacrocorax vigua*). The immediate vicinity of the town was unfavorable for collecting.

On August 26 we landed at Callao, and had time for an excursion to Lima, where we saw the Zoölogical Gardens, but did no collecting. The next day we stood off Salaverry, which is on a barren sand bank, though the hills back of town, at 1,000 feet or more, are green and shrouded in fog. The last stop in Peru was at Paita, quite at the northern end of the country. In about an hour we captured six species of bees, four of them new to science, and one of the others including an undescribed sex.

Going up the coast of Peru, we passed the Guano islands, so well described in Murphy's *Bird Islands of Peru* (1925). The number of water birds was amazing. Those especially noted about the ship were pelicans (*Pelecanus thagus*), cormorants (*Phalacrocorax bougainvillei*), gulls (*Larus dominicanus*) and the so-called cape pigeon (*Daption capense*). We also saw sea lions (*Otaria byronia*). Mr. Chas. D. Fagan, the wireless operator on the "Santa Elisa," is a most enthusiastic ornithologist, and on his trips up and down the coast has obtained some rare and interesting birds,[1] including Hornby's petrel, long known only from a single specimen. The birds come on board the ship, attracted or bewildered by the lights.

A day was spent going through the Panama Canal. During our passage a wasp (*Polybia occidentalis* var. *albopicta*) and some other insects came on board. We reached New York on Labor Day, and after a visit to the New York Botanical Garden left for Boulder.

It was a long journey, packed with varied experiences, worth while equally for the scientific results, the knowledge of physical conditions, and the delightful contact with all sorts of interesting people.

On the way down, I wrote the following poem, which was printed on the menu card of the "captain's dinner," the night before reaching Rio de Janeiro. The "fairies" referred to are the characteristic translucent-winged butterflies.

Gone to Brazil! O mystic word!
Visions of spice and of star-lit skies.
Ocean blue where the tropic bird
Shines in the sun as it flies.
While over the land from the sea-washed strand
To the forests of palm and vine,
Strange fairies preside and silently glide
Like the ghost of a being divine.

[1]See Wetmore, *Condor*, XXV (1923), p. 170.

A Museum Pilgrimage

By HERBERT P. WHITLOCK
Curator, Minerals and Gems, American Museum

When that Aprille with his showres swoot
The drought of Marche hath percéd to the root.
. . . . . .
Thenne longen folk to go on pilgrimages.
THE CANTERBURY TALES

IT has been said that a museum curator should have, among other qualities, "the acquisitiveness of a rag picker," which I take to mean not only the knack of gathering in good things for the collections of his museum, but the gift of appropriating from here, there, and everywhere the ideas that will render these collections more obvious and intelligible. The ideas may come from a well displayed shop window, but they are far more apt to be inspired by what may be seen in some other Museum—any museum whether devoted to art, history or science, provided it be a good one, where care and thought have guided the installation.

So it was that having a longing, like Chaucer's goodly fellowship, to go on a pilgrimage, the middle of April found me on my way to France determined to see what I could of the museums of France, Spain, and Italy, and to glean from these many shrines of Art and Science those impressions and suggestions of arrangement and presentation which are no small part of the stock in trade of every museum worker.

Paris, which was my first objective, is preëminently a city of fine museums; here the wealth of culture which has always characterized this queen of cities finds expression in an assemblage of important collections of great variety. My chief interest being in science museums, it was natural that my first visit should be to the Natural History Museum in the Jardin des Plantes. Here I found a museum with an atmosphere and tradition which plainly bespoke the classic age of Science. In these famous halls I felt almost prepared to meet the shade of the Abbé Haüy, whose historic collection of minerals is preserved here; or that of Cuvier, whose house near by in the Rue Cuvier is still preserved with a care which seems as strange as it is beautiful to the eyes of a mere New Yorker. But the Jardin des Plantes can boast of other things besides the Haüy Collection. There is a very complete collection of minerals particularly rich in those from French localities and including a superb suite of the gem minerals from Madagascar. Also noteworthy is a series of cases devoted to the minerals occurring in certain rock types (such as the minerals of eruptive rocks). Supplementing this is a fine series of rock structures.

In the section of anthropology my attention was drawn to a well displayed series of casts of the hands and feet of the races of men, a highly significant and original installation. As in most of the natural history museums that I visited, the collection of birds was large and fine and especially rich in tropical birds.

Not far from the Jardin des Plantes, at the rear of the Jardin du Luxembourg is l'Ecole des Mines which houses a mineral collection said by some authorities to rival that of its

neighbor the Natural History Museum. A wall case series displays the large and fine specimens of this collection after the manner of the wall case key exhibit in our Morgan Hall. There are also many exceptional pieces in the general collection exhibited in flat cases. On the whole this collection of minerals is a classic and historic one, rich in its associations with the men who have laid the foundations of mineralogical science.

In treading this hallowed ground on the left bank of the Seine, as all good pilgrims should tread it, Paris taxicabs to the contrary notwithstanding, I spent several very profitable hours in the Musée de Cluny, examining a very famous collection illustrating old French culture. Here were displayed many objects illustrating the antique use of precious stones in Gallo-Roman and Merovingian art. By far the most important of these are the seven crowns of Visigoth kings, set with roughly shaped gem stones, and constituting perhaps the finest known examples of the use of precious stones in the jewelry of the seventh century. The handbook by Edmond Harancourt, curator of the Musée de Cluny, printed in English as well as in French, is not only an admirable guide book to the collection, but a model which might well be studied with profit by any one engaged in the difficult task of preparing a museum handbook.

The crowning glory of Parisian museums is, of course, the Musée National du Louvre, and hither I next turned my steps to see the Salle des Bijoux Antique, a notable collection illustrating the historic use of gem stones. Here I found a splendid assemblage of engraved gems and ring mounts displayed on moiré silk of the same shade as that used in our Morgan Collection. The Egyptian gold jewelry in this section of the Louvre well repays a visit, containing, as it does, finer pieces than any others I have seen. Among the cases in the adjoining gallery I saw one in which small silver figurines were displayed on a stepped supporting diaphragm, the upright elements of which consisted of mirrors which reflected the back portions of the specimens. Such an arrangement is very effective for the display of small objects which should be seen on all sides.

From the Louvre it is only a step to the Bibliotheque National in the Rue de Richelieu. Here I found the best series illustrating the historic evolution of gem engraving, within my knowledge. This begins with Babylonian and Assyrian cylinders and shows successively Asiatic, Greek, and Roman intaglios, ring mounts, the inscribed talismanic seals of Arabia, Turkey, and Armenia, Gnostic intaglios down through Christian engraved gems, and Medieval intaglios and cameos to modern equivalents. It forms an almost unbroken exposition of the art of the gem engraver. Each example is accompanied by a sharp impression in plaster and the group labels are lucid and well chosen. Nor does this collection lack notable specimens among its hundreds of examples, since here I found the splendid antique cameo, representing "The Glorification of Germanicus" one of the largest and finest cameos known. As one would be led to expect of so good an installation, the handbook which describes it is well written and well illustrated.

In the Musée Carnavalet (Fig. 1), which is fairly close to the Louvre in the Rue Sevigne, I had my first view of a typical "museum of culture" which is an extremely common type throughout

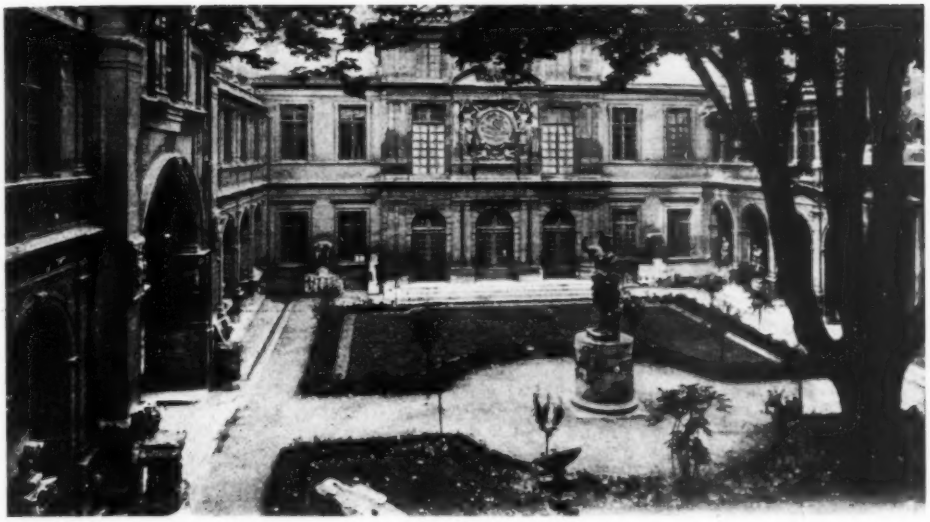


Fig. 1.—A garden court in the Musée Carnavalet. Enclosed gardens are fairly common among the museums of France and Italy. They are always well kept, and add much to the dignity and attractiveness of the building

France, Italy, and Switzerland, and probably throughout the whole of Europe. In America we would call this kind of a museum a "historical" museum; in Italy where it flourishes it is called a "civic museum" (Museo Civico). The Carnavalet Museum is in reality an old Paris residence turned into a home for objects illustrating the history of Paris, particularly the epoch of the Revolution, in much the same way that Jumel Mansion is maintained in New York or Washington's home at Mount Vernon. Some of the rooms have been reproduced in their original furnishings in a way analogous to the rooms of the American wing of the Metropolitan Museum, or similar restorations in the Boston Museum of Fine Arts. One of the charming features of the Carnavalet Museum I must mention because I found it repeated with variations so often in the course of my travels. The plan of this old house is such that the main edifice encloses four courts or gardens—not merely places where the public may eat lunch and scatter papers, as too often is the case when such things are attempted with American museums, but real gardens where one may saunter, and review what one has seen, may read and digest the guide book, and take away, as I did, something more than the mere impression of beautiful costumes, Revolutionary relics, and those clever little scale models of sections of old Paris.

Among the very many things that Paris holds tucked away from the eye of the casual tourist is a small but very interesting museum devoted to the religions of Japan, China, and India. This is the Musée Guimet in the Place d'Iéna. Here I saw a collection rich in interest and exceptionally well lighted and displayed. A feature which impressed me as most unusual was the number of pieces that were mounted without case protection. I found, later, that this practice was by no means confined to this museum, but was used in many of the Italian civic museums

with a freedom which seems very surprising to one familiar with the American public. In one of the long galleries, lighted from the side, is installed a number of busts on square pedestals of the usual type. What is unusual, however, is the use that has been made of the side light. The pedestals are slightly turned so that the heads displayed catch the light in three-quarter aspect instead of the usual half aspect. Figure 2 explains this innovation which is far more effective than it sounds.

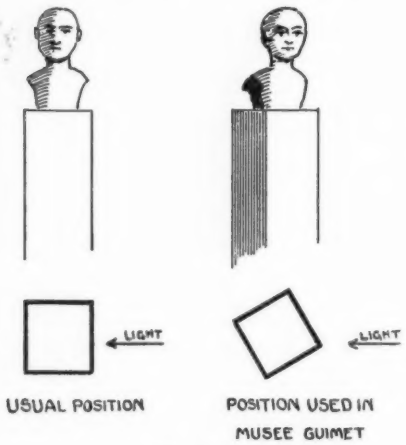


Figure 2

Five minutes' walk from the Place d'Iéna takes one to the Palais du Trocadéro, which contains two museums that are well worth a visit of several hours apiece, although, like the Musée Guimet, they are not generally featured in a tourist's itinerary. The most impressive of these is the Museum of Comparative Sculpture, where casts of practically all that are important among French architectural monuments are arranged by periods.

For lighting and interest of arrangement this museum is by far the best which I had the privilege of studying. The overhead lighting is admirably suited to bring out the detail of the architectural reproductions exhibited, many of which are twenty feet in height. Great skill has been displayed in the arrangement of reproductions of portals and façades which are employed to divide the long curved hall (220 yards in length) into smaller elements, one opening into the other. This installation presents a most interesting and impressive solution of the problem of treating a long and relatively narrow exhibition space. Nothing is under glass.

The Ethnological Museum, also in the Trocadéro, deals with the peoples of the world, with a strong emphasis on the people of France. A striking feature of this installation is the exhibit of costumes, shown on life-size figures distributed throughout the collections. In dealing with the peoples of America, single figures are used to illustrate the aborigines of North, South, and Central America. The peasantry of France are shown in a series of attractive groups under glass, exceptionally well mounted and labeled. I was delighted to find in this series a group showing the peasant lapidaries of the Jura Mountains polishing semiprecious stones. In this section also the collections of headdresses, foot gear, and other elements of costume and employments are well arranged and displayed.

I also visited the magnificent collection of French armor in the Musée de l'Armée, a collection of great importance and interest, but one which taught me nothing new in installation.

At Bordeaux, where I broke my journey en route for Spain, I found a small natural history museum, of which the outstanding feature of installation is the ethnological section. This contains a good collection of weapons and other elements of culture from French colonial possessions, no-

tably from Senegambia and New Caledonia.

On reaching Madrid I lost very little time in finding my way to the National Museum of Natural Sciences in the Palacio de la Industria. This is a modern museum in which modern methods of group mounting and display have been followed to a certain extent. There are several good animal and bird groups. The large mammals are shown in wall cases six feet deep, and divided into panels five feet wide. Each panel contains a group of species (such as *Felis*), and instead of a label, each specimen bears a number corresponding to a numbered list of the species in the group. This list is mounted against the glass front of the case. From an educational point of view there is quite an advantage in this method of labeling, for the visitor is continually led to place a particular specimen among its related species. The collection of minerals is installed in cases of the desk type, in a room lighted from above. Ordinarily such an installation would be marred by very bad reflections from the glass of the cases. In this instance, however, the effect of the strong Spanish sunlight is minimized by a dark curtain suspended in a horizontal position under the middle third of the ceiling skylight, in the manner shown in Figure 3.

Among the museums of Madrid I found one which was rather unique,—the Museo Naval, in the building devoted to the Minister of Marine and close to the Royal Palace. I had never before seen a naval museum, and was delighted to find here a really fine collection of ship models, beautifully constructed to scale, and illustrating Spanish vessels of war from the galleons of the fifteenth century to the most modern warship. The collection, which is admirably lighted and displayed, might well be considered a good standard for this type of museum.

Coming out of Spain on the eastern side of the Pyrenees, I made a stop at Marseille in order to see the natural history museum of that very delightful port. It proved to be a good example of a local science museum, excellent in certain departments. There are, for instance, good local collections of fossils, including a fine series of fossil insects from the Eocene of Aix-en-Provence. The local birds are also well represented and there is a quite complete series of Mediterranean fishes. Some of the halls have been decorated with mural paintings depicting restorations of extinct life, and some of the geology halls with examples of natural scenery such as a glacier, a waterfall, a tropical forest.

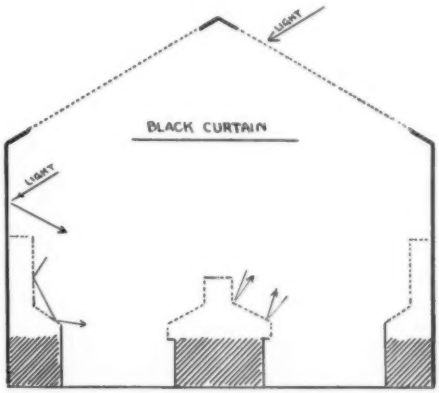


Figure 3

At Genoa, my first stop in Italy, I happened upon another museum of the type of the Guimet in Paris, but much smaller and less pretentious. This was the Museo E. Chiossone in the Accademia della Belle Arti. In the display of the collections of Chinese and Japanese art objects, which constitute the exhibits of the Chiossone, great taste has been exercised. I found noteworthy the use of background diaphragms

which is suggested in sketch diagram in Figure 4. In the example studied the material displayed consisted of Chinese masks; as an installation suggestion, however, the idea seems susceptible of a wider application.

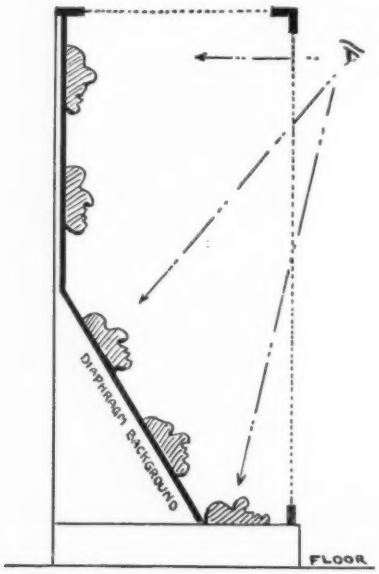


Figure 4

It is a considerable jump from Genoa to Rome, my next halting place, but a jump necessary at one time or another, since Italy is long and narrow, and one must see it journeying either south or north.

There are in Rome many museums of art and archæology, but few science museums; so, accommodating myself to conditions, I made the most of the archæological museums, and brought away from the National Museum at Rome what I consider the most valuable idea among my notes.

This is another museum, which, like the Carnavalet, encloses a charming garden, which was at the height of its June splendor when I saw it. Although mainly devoted to sculpture, the National Museum contains a small but important collection of Roman jewelry and small objects in amber. It was while I was studying these that I found the very unique treatment of supporting glass shelves upon diaphragms which I have sketched in Figure 5. The installation in this upright wall case consisted of supporting a glass shelf on a background diaphragm of convenient height, say 12 inches; then another diaphragm and glass shelf, and so on to the top of the case. This constitutes what a patent lawyer would call a "basic" idea. Its application to any installation using glass shelves is practically limitless, and its use where Roman pottery was shown was highly effective.

My way north from Rome took me first to Perugia, that fascinating hill town, beloved of all good tourists who know their Italy a bit more than superficially. Perugia supports a museum of Etruscan-Roman art which is rich in beautiful things. Among the Etruscan antique objects, I found a number of examples of the use of gem stones in Etruscan jewelry. It was extremely interesting to compare this series, and the one which I had just seen in Rome, with the Egyptian forms from the Louvre collection, and from what I remembered of the Metropolitan Museum's series. In every instance where emeralds were used as beads I noted that the stone had been left in its rough (hexagonal crystal) form and merely pierced for stringing. This was in marked contrast to the practise used for other gems which were invariably shaped into some primitive bead form.

There is also a tiny natural history museum in Perugia which, despite its small size, displayed a series of old crystal models illustrating the theories of Haüy regarding crystal structure. As one who makes crystal models, I

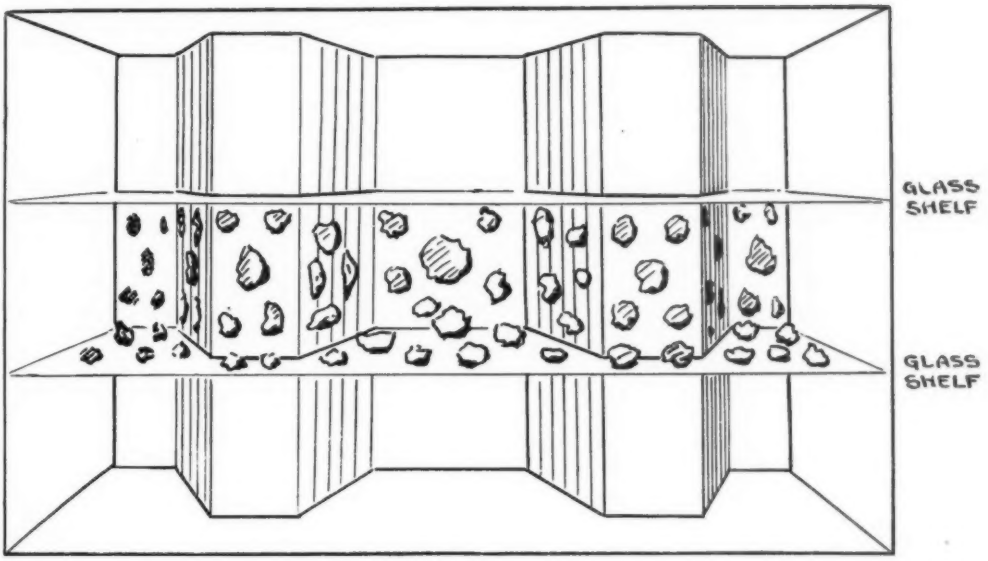


Figure 5

gazed with appreciation and reverence on these beautifully constructed cardboard solids and speculated as to how long they had been there, and whose patient labor had produced them.

One thinks of Florence as the Italian city *par excellence* of the art museum. I can, however, bear witness that there are also science museums, and good ones, to be found in Florence, if one will but seek them out. The Natural History Museum of Florence in the Via Romana, in reality only houses the zoölogical and anatomical sections,—the sections of geology and mineralogy having been removed to separate buildings. The collection of invertebrates is large and well lighted as is also a splendid collection of the birds of Italy. By far the best installation is that of a series of wax models of anatomical preparations and dissections, beautifully made and well arranged and displayed. These fill several rooms, and constitute a good example of the importance laid upon anatomy in several of the science museums which I visited.

In the entry to the Natural History Museum I found a number of exhibition cases filled with astronomical and physical apparatus preserved as relics of such famous scientists as Galileo and Torricelli,—a veritable shrine for such a pilgrim as myself.

The mineral collection of the University of Florence, housed in a building adjoining the Piazza San Marco, is a fairly large collection, well lighted and displayed. A feature of this museum is the collection of minerals from Elba, which includes many species not to be found in most collections from this highly interesting locality. A similar collection of the minerals of Tuscany (largely from Bottino) is projected, and the material is at hand awaiting installation.

In the Florentine National Museum, which covers a field of culture analogous to that of our art museums, I again found much to interest me. The collections, which are exceptionally well displayed, are rich in Medieval and Renaissance examples of the use of gems.

On the lower floor of the Pitti Palace, one entire room is devoted to objects in carved amber. This, as one would

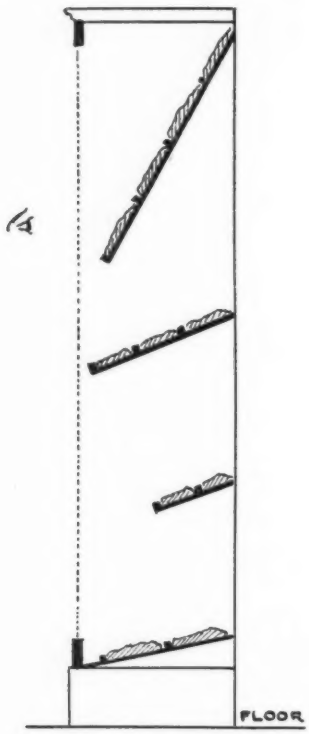


Figure 6

suppose, is mostly the dark Sicilian amber which is becoming increasingly more difficult to obtain. There are also in the neighboring rooms on this floor several pieces of carved rock crystal (some by Cellini) which are very fine.

At Bologna, the next museum city on my line of travel north through Italy, is to be found one of the oldest universities in Europe. Here I visited a geological and a mineralogical museum, both parts of the University, and each in a separate building, although within a stone's throw of each other in the Via Lamboni. In the geological museum, dedicated to G. Capellini, a former director, is an effectively displayed collection rich in Italian fossils and rocks. The section devoted to fossil plants is especially complete. There are also fine examples of *Ichthyosaurus* both in original and in casts, and many skulls and several complete skeletons of the cave bear. Room XI contains a fine cast of *Diplodocus carnegici*. A feature of this installation is the complete series of rocks and fossils from specific regions, many of the series being accompanied by explanatory relief maps. I sketched an upright case, which was being employed to display rock specimens, because the arrangement of inclined shelves to present a group of surfaces normal to the line of sight seemed novel and certainly was very effective. Figure 6 shows this shelf arrangement, applicable to slabs of fairly uniform thickness.

The Mineralogical Museum of the University of Bologna upholds the tradition of its neighbor the Capellini Museum of Geology in emphasizing local mineralogy. Here are to be found some exceptionally fine series of occurrences from Italian localities arranged by provinces. Of these the sulphur and gypsum from Romagna, the series from the Island of Elba, the Sardinian phosgenites, cerussites and anglesites, and

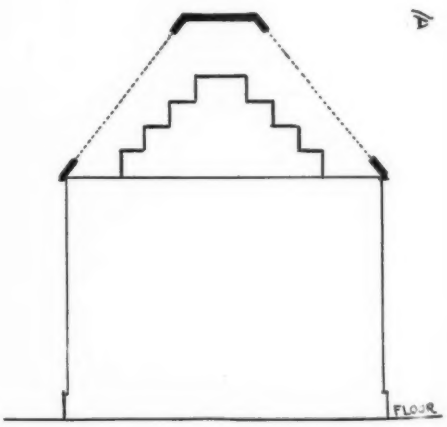


Figure 7

the Bottino and Bavino minerals are finer than any I have as yet seen. There is also a good general series displayed in stepped cases with inclined fronts. So effective is the method of display in these cases, that I have added as Figure 7 a diagram of one of them from my notes. Most of the collection was brought together by Bombicci during the latter half of the last century, and is rich in his type material.

Padua, another city of north Italy, made famous by its old and renowned University, was not to be passed by in my wanderings. The old University of Padua turned out to be one of the most interesting things that I saw in Italy, rich as it is in relics and associations. Here are preserved, among many historic links with the classical period of scientific growth, the first surgical or clinical theater ever constructed, and the actual wooden steps by which Galileo mounted the scaffold to make his famous renunciation, with its still more famous reservation. I found a good local collection of fossils arranged stratigraphically and also by provinces, with, in some instances, a relief map of the region covered by the series placed at the end of the case to show the stratigraphic relations. The cases containing this collection were of sufficient interest to warrant a sketch, which I have reproduced as Figure 8. In the palæontological section of this little museum is a fine series of fossil fishes from the Oligocene, and some undescribed vertebrate material from the Oligocene of Venetia. In this section, also, is a splendid series of skulls of the cave bear.

Traveling is mostly made up of a succession of contrasts, and certainly the contrast was strongly marked between Padua, the old-world university city, and Milan the beautiful "Paris of North Italy," which was my next objective. Milan boasts of the finest and most modern science museum in Italy, the Civic Museum of Natural History in the Public Gardens, Corso Venezia, Fig. 9. This is not only the largest and best in Italy, but it stands out from all others that I saw in the orderly arrangement and sequence of its collections. This sequence is so significent that I give it here in detail. The rooms numbered successively to the left of the entrance are designated as follows:

Room I, Minerals (General); Room II, Regional Minerals and Rocks; Room III, General Palæontology;

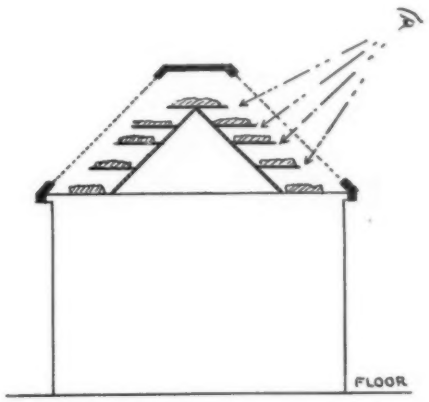


Figure 8

Room IV, Lombardy Rocks and Fossils; Room V, Lombardy Fossils; Room VI, Comparative Anatomy; Room VII, Comparative Anatomy; Room VIII, Mollusks and Brachiopods; Room IX, Insects and other Invertebrates; Room X, Mammals; Room XI, Italian Mammals; Room XII, Regional Minerals and Decorative Stones.

The apparent lack of sequence with reference to Room XII disappears when we consider its situation at the *right* of the entrance, the round of the numbered rooms bringing us back to

the starting point; this brings it in near relation to Room I.

I found in Room I a very well selected general collection of minerals comprising between 3000 and 4000 specimens, well displayed in wall cases (on shelves) and inclined-front stepped cases. The cases of the latter type were freely used throughout the entire installation for small specimens, with or without a stepped interior equipment, and I found the type so generally effective that I have sketched it in Figure 10 in its application to the display of mineral specimens. The only criticism of this variant of the inclined front case is that the deck has been built too high to accommodate children. Room I also contains some well arranged supplementary collections illustrating crystallography, physical properties of minerals, and mineral structure and pseudomorphs.

Room II contains a splendid series of rock types, mostly representative of Italian occurrences, and a series showing rock structure. Both of these are particularly well selected and contain many striking examples.

In Room XII is a collection of about 2000 minerals arranged by localities and representative of the important deposits of Europe. This suite is valuable for comparison and for study of special problems. Around the walls is a beautiful collection of Italian marbles.

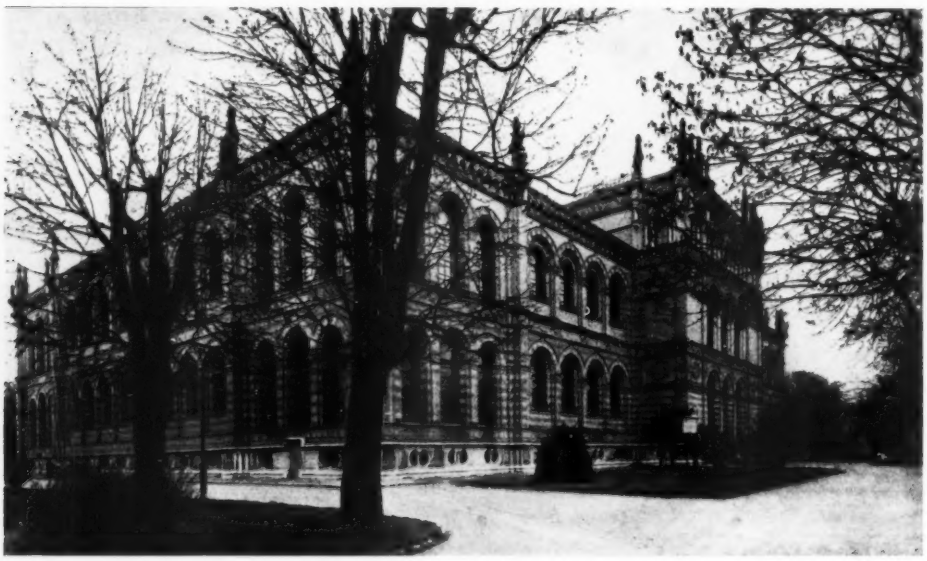


Fig. 9.—The Civic Museum of Natural History at Milan. Turning to the left on entering, one passes through a series of twelve rooms, returning to the entrance shown at the right

Visitors to Milan, after seeing the Cathedral, usually devote their next half day to the art and history collections in the "Castello." This installation gives a very successful solution of the problem involving the use of a historical building as a repository for art objects, without sacrificing either the impressiveness of the historical monument or the effectiveness of the art collection as a record of culture. What little glass casing is used is unobtrusive and well disposed, and there is no crowding, except pos-

sibly in the instance of the room devoted to furniture.

I also saw in Milan the large and well equipped Archæological Museum (Via

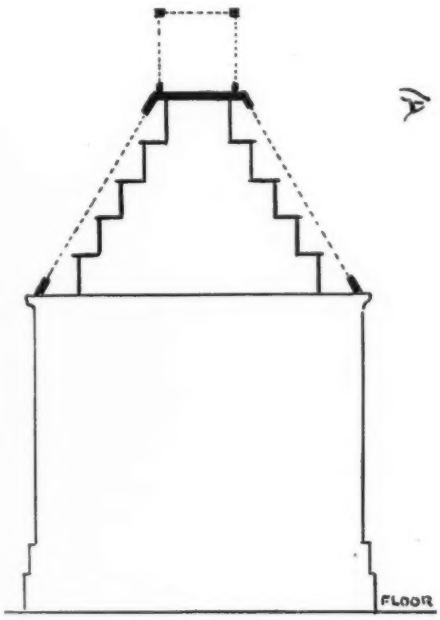


Figure 10

de Brera) which is thoroughly modern in type. The Egyptian section in particular is deserving of high praise. It includes a tomb restoration similar to that in the Metropolitan Museum. Prehistoric archæology is also treated effectively and in detail.

A civic museum of local culture, thoroughly characteristic of Italian museums of this type, is that of Turin, the next point of my itinerary. The collections are largely devoted to local Medieval and Renaissance culture. Much of the material is very attractively displayed, as for instance, the collection of eighteenth century book bindings, displayed in upright cases. The diaphragms used in this installation seem to me to be of such general application that I have reproduced my sketch of them as Figure 11.

Turin can also boast of the most modern of all museums, a World War Museum. This is located in the War Monument known as the Mole Antonelliana. As would be natural with such a recent installation, the material is comprehensive and complete in detail. There is much which should constitute a standard for similar installations, notably the elaborate relief models of the sections covered by the Italian-Austrian battle-fields.

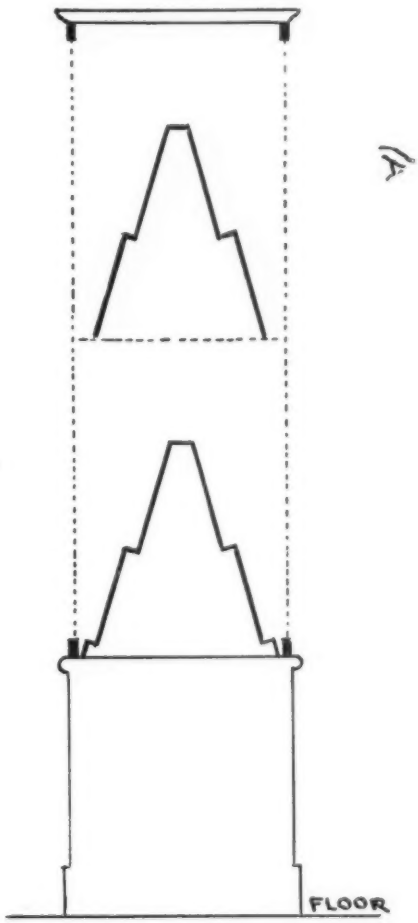


Figure 11

Geneva, which I next visited, is a city which is rich in small museums of various types. The natural history

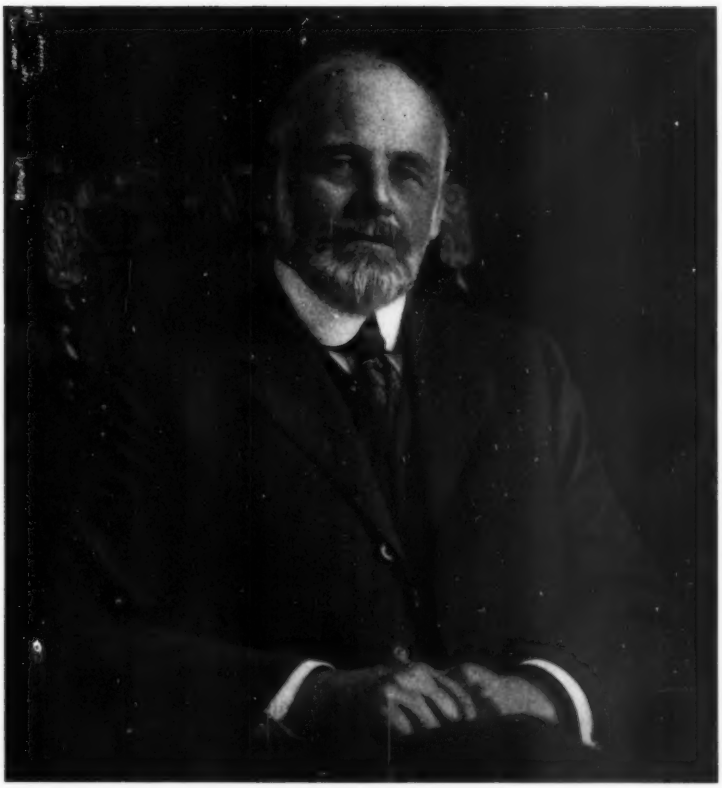
museum of the University, in the Promenade des Bastions, contains collections of comparative anatomy which are notably complete and well displayed. The section of mineralogy has several striking exhibits, especially the superb group of Swiss quartz crystals in the entrance hall.

The museum, however, which would alone justify one's turning aside to visit Geneva is the splendid Museum of Art and History in Rue des Casemates (Fig. 12). This museum displays in a thoroughly up-to-date manner the complete history of Swiss culture. The halls devoted to the local Stone, Bronze, and Iron ages are well developed, and the material is displayed with great judgment. From this early culture the series is carried through Roman and Middle Age halls, to the most modern expressions of Swiss art and industry. The collections are very comprehensive, and are without exception arranged with great taste and intelligence.

In the Botanical Gardens is located the Musée de l'Ariana, a small but attractive building containing a somewhat "Mid-Victorian" collection of art objects, which is, on the whole, displayed with care and effectiveness.

The chief collection of the Ariana Museum is an especially fine series of ceramics which I certainly found worth a visit. The halls are well lighted and the whole atmosphere of the place has a charm which invites one to linger. And linger I did for the whole of a glorious peaceful afternoon, for Geneva was the end of my pilgrimage, and when one has seen so much in so many places, the effect on the mind is somewhat similar to the effect on the body, of one of those famous Spanish dinners. There is grave danger of "museum indigestion."

Fig. 12.—The Museum of Art and History at Geneva. An imposing museum of a very modern type, in which the historical development of Swiss culture is featured



James Furman Kemp, professor of geology at Columbia University for thirty-five years, and one of the foremost geologists of the United States

James Furman Kemp
1859-1926

By CHESTER A. REEDS
Curator of Invertebrate Palæontology, American Museum

PROFESSOR KEMP was a remarkable man. Everyone who came in contact with him admired him, and instinctively felt that he was a personal friend. On the campus and in many gatherings he was known as "Uncle Jimmy," a sobriquet which had its origin in the great affection his students had for him. As a teacher he possessed a wide knowledge of geology and related subjects, exceptional facility in presentation, and a rare combination of kindliness and serious concern, coupled with a never failing buoyancy and humor. His inimitable manner, ready tact, and elegant form of expression made him particularly desirable at important meetings. Organizations with which he was affiliated looked to him for counsel and conferred many honors upon him. He was actively engaged in his professional duties until the morning of November 17, 1926, when he was stricken as he was about to board the train at Great Neck, Long Island, for Columbia University.

He was born in New York on August 14, 1859, and came of a line of Scotch and English forbears. His parents were James Alexander and Caroline (Furman) Kemp. After graduating from Adelphi Academy in Brooklyn in 1876, he went to Amherst, where he graduated with the degree of A.B. in 1881, after which he came to the School of Mines, Columbia University, where he received the degree of Engineer of Mines, with the class of 1884. Then followed graduate study at Munich and Leipzig. Returning to America, he taught geology at Cornell University from 1886 to 1891, when he became assistant professor. Coming to Columbia as adjunct professor in 1891, he was appointed head of the department of geology on the death of J. S. Newberry the following year.

His *Ore Deposits of the United States and Canada*, issued in 1893, passed through many editions. In 1895, his *Handbook of Rocks* appeared and went through many editions. In addition to his writings on economic geology, he also contributed much to the knowledge of pre-Cambrian rocks and to the application of geology to engineering problems. He was consulting geologist on the new Croton Dam, and the Catskill Aqueduct for the Board of Water Supply of New York City. As a recognized authority on ore deposits he was often called as an expert in litigation over the ownership of ore-bodies by mining companies, and was repeatedly called into consultation by the Anaconda Copper Company, and the Calumet and Hecla.

He became a member of the Mining and Metallurgical Society of America in 1891, served as a member of the Board of Managers, 1896 to 1898, vice-president, 1903 to 1904, director, 1905 to 1914, and president in 1912. He was an Original Fellow of the Geological Society of America, and its president in 1921, president of the New York Academy of Sciences, vice-president of the American Association for the Advancement of Science, a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, the Century Association, the National Research Council, Washington Academy, Washington Geological Society, American Geographical Society, School of Mines Alumni Association, American Association of Petroleum Geologists, the Society of Economic Geologists, a corresponding member of the Academy of Sciences of Oslo, Norway, Geological Society of Belgium, and Geological Society of London.

He was non-resident lecturer in ore deposits at Johns Hopkins, 1905–1906, in economic geology, Massachusetts Institute of Technology, 1907–1908, and in geology, McGill University, 1910. For many years he was associate editor of *Economic Geology*, and the *School of Mines Quarterly*. In 1926, he was spokesman for the American delegation at the International Geological Congress held at Madrid, Spain.

He was for years manager and scientific director of the New York Botanical Garden. He loved flowers. On November 4, 1926, he wrote me: "I was sorry to miss the Section meeting of the New York Academy of Sciences Monday evening, but as I had no classes, I spent the day digging up my gladiolas and dahlias out at Great Neck, and I was too tired to go to the city in the evening. In fact my dahlia crop and banking roses kept me busy all day Tuesday as well."

He was actively connected with athletic activities at Columbia, and was

interested in all sorts of outdoor sports, but especially golf and fishing. His clubs were Columbia University and Century.

In 1906, Amherst, his Alma Mater, conferred on him the degree of Sc.D. *honoris causa*, and in 1913, McGill University awarded him the degree of LL.D.

He married Kate Taylor of Kingston, Rhode Island, in 1889. He is survived by his widow and three children, James Taylor, now metallurgist with the American Brass Company at Waterbury, Connecticut; Philip Kitteridge, rector of an Episcopal Church at Glendale, California; and Katherine Furman (Mrs. Chase Donaldson).

Professor Kemp will be missed deeply not only by his immediate family and relatives, but also by thousands of friends, many of whom gathered at the impressive funeral services in St. Paul's Chapel, Columbia University. He had an affectionate regard for all of his students, and was greatly beloved in return. His place is among the great teachers.

News from the Field

AFRICA

MRS. CARL AKELEY, from her camp on the slopes of Mt. Mikeno, at an elevation of 11,500 feet, writes that she has been continuing the work begun by Mr. Akeley in securing material for the accessories and backgrounds for the groups to be used in the African Hall.

Mr. Leigh, she says, has finished the gorilla background, and is completing the color notes for the wonderful varied vegetation of the region, of which Mr. Raddatz has made many fine molds.

The work has been carried on under great difficulties, for at the elevation at which the camp is located, the temperature varies from 44° to 36° Fahrenheit, while, in addition, there is almost constant rain, and the wind is so strong that the tents are frequently loosened from their moorings. Any "indoor" work is carried on over little charcoal fires, the workers wrapped in all the clothes they possess. But when on rare occasions the sun does shine, the view over the forest is glorious.

Mrs. Akeley plans to visit another gorilla locality and also Lake Hannington, and hopes to complete the work and sail from Mombasa by February 22.

MR. AND MRS MARTIN JOHNSON, who found in pneumonia a more dangerous foe than the elephants and lions they had been photographing, were, at last accounts, recuperating at the foot of Mt. Kenya.

Mr. Johnson also met with a serious accident in the explosion of some flashlight cartridges, but in spite of illness, accidents, and bad weather, reports that he has been far more successful than he had hoped, and "unfortunately" may return within the year. Among other subjects Mr. Johnson reports the best elephant and giraffe films he has ever made, as well as films and many single photographs of rhinos, hartebeests, wart hogs, and zebras.

Incidentally, Mr. Johnson mentions that Mr. Pomeroy has been wonderfully successful in obtaining material to complete the group of greater and lesser kudu.

AMERICA

TO PANAMA FOR BIRDS.—Mr. Ludlow Griscom sailed February 3 on his second expedition to Panama, in continuation of his study of the bird life of that country. Mr. Griscom is accompanied by Mrs. Griscom who will devote special attention to photography, and by Mr. Maunsell S. Crosby. Paul F. Covel, of the Museum's department of preparation, is taxidermist for the expedition.

ASIA

WORD FROM THE MORDEN-CLARK EXPEDITION.—Great relief was felt by the American Museum and the many friends of Wm. J. Morden and James L. Clark when, on January 5 a cablegram was received from Peking announcing that the Morden-Clark Expedition party had come to the end of its successful journey from Bombay to Peking on January 1. The object of the expedition, which was financed entirely by Mr. Morden, was to secure a series of *Ovis poli* for a Museum group, as well as ibex, antelopes, and any other interesting mammals from that remote region.

Ponies and yaks, the only beasts of burden that can go through the very deep snow or climb the rocky hills at such high altitudes, were the principal means of transportation from Gilgit to the *poli* country, where Mr. Morden and Mr. Clark were the first white visitors in twelve years, and probably the first Americans ever to have gone there.

Many remarkable still and motion pictures were taken of the wild animals and the country, which abounds in glaciers and sheer mountain peaks, some points rising to a height of 25,000 feet.

At Aktsoi, the party saw a number of *poli*, but were able to secure only two fine big specimens out of a herd of twenty. While their camp was located in this section, they frequently hunted at elevations of from 15,000 to 16,000 feet.

Later, on the trip to Shabachi, a sufficient number of *poli* were captured for a Museum family group, and some individuals which will be presented to other institutions. The average length of the horns ranged from 50 to 56 inches in length, the longest obtained being 57¼ inches. Besides the *poli*, the expedition collected marmots, bear, and wherever possible, specimens of birds.

It had been planned originally that the expedition should join forces with the Central Asiatic Expedition in order to insure greater safety in travel and larger collections of fauna and flora from this almost inaccessible country. Because of conditions in China, however, the Central Asiatic Expedition could not get through, and Morden and Clark had to proceed alone. Despite their many difficulties, they accomplished all they set out to do, and their return to America late in February, is awaited with keen interest.

Mr. Clifford Pope returned from China, late in November, thus completing his second period of work with the Third Asiatic Expedition as collector of reptiles, amphibians, fishes, and mammals. About the middle of December his collections reached the Museum.

Mr. Pope spent this last two-year period in Fukien Province where he found a rich and very interesting fauna. The collection of amphibians contains some 4000 specimens, in which about 30 species are represented, while in the 2500 reptiles there are nearly 75 species.

Devoting much of his time to life-history studies, he secured many series of developing frog eggs which show important stages in the embryology of the species concerned.

In spite of rumors to the contrary, this branch of the expedition's work was almost unaffected by the disturbances in China. The herpetological survey of the Min River Valley was completed, from sea level at Foochow to the heights of the Fukien-Kiangsi divide where the waters of the Min have their source. Mr. Pope plans to turn his attention to Yunnan and Kweichow provinces early in 1928.

News from the Laboratory

AMPHIBIANS AND REPTILES

The Museum's Fund for Experimental Research.—Museums with their large collections have always been the chief source of information in regard to animals as they occur in nature. The first question in the study of an animal is, what is it? And the next is how, or why. The most precise way of finding out why animals do this or that, or have one structure or another, is to experiment with them both in nature and in the laboratory. In former years the experimental work has been left to the universities, but recently the method has been successfully employed in museums, as one of the articles in this issue of Natural History shows.

Mr. William Douglas Burden, a Trustee of the American Museum, has realized the great importance of the experimental method in museum research and has kindly lent his motion picture, "The Dragon Lizards of Komodo," to the Museum for the purpose of inaugurating a fund for experimental work. Already several lectures have been given in New York in which this film has been used. A fund of ten thousand dollars is required to carry on the work.

ASTRONOMY

Through the generosity of Mr. S. B. Grimson, a 5" Brashear telescope has been lent to the department of astronomy. This has enabled the department to observe objects in the sky, among them Jupiter and his satellites, Mars and our moon.

On January 28 arrangements were made by Dr. Clyde Fisher, in charge of astronomy, and members of his department, for the observa-

tion of the occultation of Saturn by the moon. Before sunrise the sky was quite clear and Saturn could easily be observed as the moon neared the planet. By the time of immersion, which occurred soon after 7:00 A.M. it was somewhat hazy, and after Saturn was hidden from view, the cloudiness increased, so that it was impossible to observe emersion.

A practical proof of the sun's rotation is now being carried on, the telescope being used in projecting the sun's image upon a screen. A record is being kept of the position of the sun spots from day to day, their change of position demonstrating the rotation of the sun on its axis.

EDUCATION

CONFERENCE OF MUSEUM EDUCATORS.—A movement has recently been started for frequent conferences of museum educators in New York City and vicinity. The first meeting was held at the Metropolitan Museum of Art in December, and the second one on January 25 in the new School Service Building of the American Museum of Natural History. About fifty educators attended each meeting. The latter meeting was opened at ten o'clock with an address of welcome by President Henry Fairfield Osborn. The first paper presented was by Mr. Henry W. Kent of the Metropolitan Museum of Art on "The Development of the Educational Department of the Metropolitan Museum of Art." After a short discussion, Dr. Arthur Harmount Graves of the Brooklyn Botanic Garden spoke on "The Value of Real Objects in Nature Education." Dr. Clyde Fisher of the American Museum of Natural History followed with an address on "The Future of Motion Pictures in Education," illustrated by pictures of Dr. Fisher's children with their animal pets.

The afternoon was devoted to a preliminary inspection of the School Service Building and to some of the exhibition halls in the Museum, where the educational activities of the Museum were more fully explained.

EXHIBITION OF CURRENT BIOLOGICAL RESEARCH.—The Section of Biology of the New York Academy of Sciences revived an old custom at its December meeting. A series of demonstrations of some results in current biological research were displayed to the great satisfaction of the five hundred members and friends who attended the meeting. Twenty-two demonstrations ranging from the dissection of cells and the injection of Amoebæ to the origin of the human dentition were shown in the new School Service Building of the Museum. Because of the large numbers attending the meeting and the undeniable enthusiasm of those who in a very short time were able to gain considerable insight into the research work being done in New York, it was decided to have a similar type of program at a later meeting.

Many institutions contributed to the success of the occasion. Demonstrations were presented by members of the faculty of Columbia University, Cornell University Medical College, New York University, Bellevue Medical College, College of the City of New York, and the American Museum.

At the last meeting of the Academy February 15, Dr. Alexis Carrel of the Rockefeller Institute for Medical Research, summarized the field of tissue culture and exhibited a series of remarkable motion pictures showing the activities of living cells outside the body.

THE NEW YORK ASSOCIATION OF BIOLOGY TEACHERS held its January and February meetings in the commodious auditorium of the new School Service Building. At the January meeting announcement was made of the several aids for biology teachers which the Museum has prepared for free circulation among the city high schools. Included in the new material available for this purpose is a series of small insect habitat groups, made under the direction of Dr. F. E. Lutz. Dr. E. V. McCollum, of the department of chemical hygiene, School of Hygiene and Public Health, Johns Hopkins University, spoke on "Nutrition and Health." The February meeting was addressed by Dr. W. K. Gregory on "The Palæomorphology of the Human Head."

FISHES

MR. W. K. VANDERBILT has presented to the department of ichthyology one of two identical small sharks to serve as type for a new species related to the black-mouthed dogfish, of Europe. These were taken incident to Mr. Vanderbilt's work with the "Ara," at some 200 fathoms depth, on the continental slope off Florida. Like *Zenopsis ocellatus* (related to the European dory) and *Catulus retifer* (related to the European dogfish), this new species represents the European shore fish fauna on the continental slope of America in a transition belt between shore and deep-sea

fishes, and is not related to any American shore-fish. It thus touches on a problem of considerable theoretical interest in the distribution of life.

INSECTS

Dr. Frank E. Lutz and Mr. Herbert F. Schwarz of the department of insect life, attended the Christmas meetings of the national scientific societies in Philadelphia. Doctor Lutz was elected president of the Entomological Society of America and representative of the American Society of Zoologists on the council of the American Association for the Advancement of Science.

MAMMALS

CHINESE MAMMALS.—The collection of mammals from the Third Asiatic Expedition has been enriched by a series of 682 well prepared specimens obtained by Mr. Clifford Pope in Fukien Province, China. These were secured in three localities in the Min River Valley, ranging from sea-level to an altitude of more than 6000 feet. New to the Museum's collections are four skins of the golden cat, *Felis temminckii dominicanorum* La Touche, occurring at an altitude of from 4000–6000 feet in the bamboo and hardwood forests of southeastern China.

MINERALS

A NEW USE FOR COLORS OF GEM STONES.—To demonstrate the possibilities of using the colors of gem stones for commercial purposes, and especially for automobile bodies, a prominent firm of paint manufacturers arranged with the department of minerals of the American Museum, for a loan exhibit consisting of more than twenty examples of natural gem stones, to be displayed at the recent automobile show in New York City. Included in the group was a wide range of colors from the soft gray of flint to the deep rich red of jasper. In one slab of agate there were at least seven distinct colors so harmonized and blended that it would be quite possible to use any two or three in perfectly balanced combinations for automobile body and trim.

Recent Important Exploration Lectures

ANTARCTIC

The interesting features of exploration in the great Antarctic continent were presented to the members of the Museum by Sir Douglas Mawson on January 14. Sir Douglas' material includes superb photographic records of Antarctic animal life, including penguins and several species of seals. More than 1000 members had to be turned away because of lack of room.

AFRICA

Prince Wilhelm of Sweden delivered his first lecture on African exploration to a New York audience on the night of January 22, at Carnegie Hall. Those fortunate enough to be present enjoyed a vivid record, both in still and motion pictures, of Africa's big game animals, of its tiny pigmy peoples, of the dances and ceremonies of its natives, and their methods of smelting iron and making pottery. A fine "close-up" of a weaver bird building its nest was especially interesting. Prince Wilhelm is to be congratulated on the valuable scientific data collected during his trip, which was inspired, he said, by Theodore Roosevelt.

MT. EVEREST

The members of the Museum enjoyed a rare treat in listening to the account of Captain John Noel of the Mt. Everest Expedition of 1924. Captain Noel gave his lecture first on November 7, but so many members had to be turned away because of lack of seating capacity that Captain Noel kindly repeated his lecture on December 23. By means of still and motion pictures, he showed the heroic efforts that were made to ascend Mt. Everest. The climbers had to abandon the attempt when they reached 28,000 feet, 1000 feet from the summit. Captain Noel's pictures are superb, and give a wonderful description of the country and the Tibetan people.

GREENLAND

On the evening of January 13, Mr. George Palmer Putnam, leader of the American Museum Greenland Expedition, gave to members an illustrated account of the results of the season's field work. This expedition secured a fine series of narwhal, walrus, and other mammals, and birds, needed for the Museum's new Hall of Ocean Life. Mr. Putnam's lecture attracted such attention that he gave it twice in order to accommodate the members desiring to obtain admission.

EAST INDIES

The first showing of the pictures of the dragon lizards of Komodo, secured by the Douglas Burden East Indian Expedition, was given at the annual meeting of the New York Academy of Sciences December 21. Mr. Burden secured a complete series of these giant lizards.

New Members

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 9340.

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Mr. PERCY R. PYNE.

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Mr. GEO. F. BAKER, JR.

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Master: Jack Quistgaard Petersen.

THE AKELEY MEMORIAL NUMBER

MARCH-APRIL

The March–April number of Natural History will be largely a memorial number, devoted to an appreciation of Mr. Akeley and the varied lines of work in which he was interested: it will include some of the addresses made at the Memorial Meeting, among them that of Baron de Cartier de Marchienne, who spoke of Akeley as a conservationist, and especially of the Gorilla Sanctuary he was instrumental in obtaining, and where he now rests.

Some of the many inventions of Akeley are discussed by F. Trubee Davison, and F. A. Lucas tells something of the career of Akeley as a taxidermist, in which he did so much not only to place taxidermy among the arts, but what was even more important, to make its results permanent.

Mrs. Mary Hastings Bradley, who was in Africa with Carl Akeley, gives some interesting reminiscences of the expedition to the Kivu region to obtain gorillas for the group in the American Museum of Natural History.

Mr. Edgar R. Waite, of the Australian Museum, tells how the native Australian uses the boomerang, a weapon well known by name, though generally associated with politics but whose use and principle are little understood.